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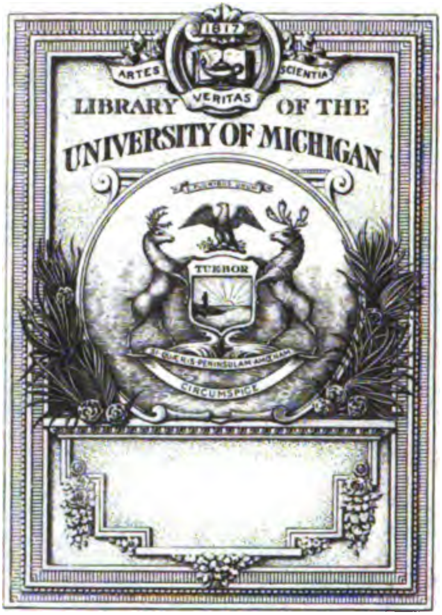

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BULLETIN No. 11.

NOTES ON THE COUNTRY
BETWEEN
EDJUDINA AND YUNDAMINDERA,
NORTH COOLGARDIE GOLDFIELD,

BY

A. GIBB MAITLAND,
GOVERNMENT GEOLOGIST.

WITH TWO MAPS.

Issued under the authority of the Hon. H. Gregory, M.L.A.,
Minister for Mines.

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1903.

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Transfer 3-31-55

NOTES ON THE COUNTRY

BETWEEN

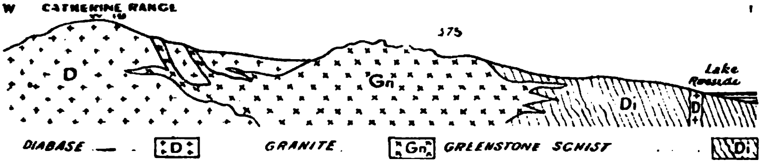
EDJUDINA AND YUNDAMINDERA.

GENERAL.

The country between Edjudina (Lat. 29° 44′ 40″ S.) and Yundamindera (The Granites) was examined by myself in the early part of the year. Leaving Niagara, the route *via* Yerilla was followed. No mining was going on at Yerilla, hence very little was to be seen of the conditions of affairs prevailing underground.

Mount Cay (W 11), a low though conspicuous rise, situated some distance to the south-west of the Yerilla townsite, is formed of a somewhat siliceous lateritic ironstone of the type prevailing in the district. No section was seen showing the rock upon which the bed rests.

To the south-eastward the Mount Catherine Range, upon the most conspicuous summit of which is situated Trig. Station W 19, consists of diabase. The diabase is intersected by dykes of granite as shown in a traverse from Catherine Range to Lake Raeside.



SECTION FROM CATHERINE RANGE TO LAKE RAESIDE

FIG. 1.

Some of these dykes pass gradually into coarse felspar porphyry (4426, 4423). Further to the eastward the granite gives place to greenstone schists, associated with which are bands of breccia (4398), which may possibly be of volcanic origin.

These greenstone schists are traversed by diabase (?) dykes, a good section of one of these being exposed in the cliffs surrounding a small rocky island in the bed of Lake Raeside, bearing 211° from Mount Catherine. The dyke exposed on the eastern side of the island has a strike of 255°, is vertical, and about three feet in thickness. There are no sections visible which clearly prove the relation which the dyke rocks bear to the massive diabase of Mount Catherine, though the impression left on the mind is that they are part of the same igneous mass, and that the greenstone schists are much older.

Near the lake some low bluffs show a thin covering of laterite resting upon the weathered greenstone.

The Mount Catherine Reef, which was opened up in the early days, stands out boldly upon the surface, with an average strike of 188 degrees. The reef, a pure white quartz, is vertical, and, as measured in the crosscut which had been put in across the vein some distance below the surface, attains a thickness of about 12 feet. The reef has a considerable horizontal extent.

From Yerilla to Yilgangi the road wends generally south-east but few, if any, sections of the underlying rocks are exposed *en route*. Between Yilgangi and the well about three miles west from Yarri (New Edjudina), no sections of the underlying rocks were visible.

YARRI (NEW EDJUDINA).

The mining centre of Yarri (or New Edjudina) is situated about six miles west of Edjudina. The relative situations of these will be found by a reference to the geological map attached to this report, or the lithograph (L 50) issued by the Department of Mines.

The country rock consists of a massive greenstone (diabase), some portions being very coarse in texture (4417), penetrated by bosses of granite (4421), from which dykes of aplite (4420) emanate. The Government well has been sunk in granite. The quartz reefs traverse both the granite and the greenstone, as is well shown on the geological map. The reefs occurring in the granite, however, are, when viewed as a whole, approximately parallel to one another, and trend generally north-west. The reefs in the greenstone strike at varying angles, although when their position is laid down on a map a general east and west trend may be detected.

Whatever may be the date of the intrusion of the granite, it is quite clear that the formation of the auriferous quartz reefs took place much later.

The matrix of the reef in the Wallaby G.M.L. 581 is a transmuted granite, an analysis of which is shown in the Table I. herewith. A microscopic examination of this granite shows that the rock has undergone considerable dynamic alteration.

TABLE I.

Analyses of Rocks.

Geological Museum Number	4,426	4,419	4,417	4,425
Specific Gravity	2·64	2·67	3·04	3·04
Silica, SiO_2	70·82	71·55	46·55	48·06
Carbonic anhydride, CO_2 ...	·40	*Nil*	Trace	1·03
Phosphoric anhydride, P_2O_5	Trace	Trace	·06	Trace
Titanic oxide, TiO_2	·35	·74	1·12	·90
Combined Water, H_2O ...	·27	·55	1·31	·59
Soda, Na_2O	5·57	4·98	1·50	2·50
Potash, K_2O	1·94	1·56	·33	·27
Magnesia, MgO	·87	1·07	9·80	6·67
Lime, CaO	2·20	1·79	10·56	11·37
Manganese protoxide, MnO...	·13	·39	·45	·59
Iron protoxide, FeO	1·73	1·58	8·79	10·37
Iron peroxide, Fe_2O_3 ...	·51	·77	3·19	·89
Alumina, Al_2O_3	15·56	14·82	15·36	16·21
Pyrites, FeS_2 : Iron, Fe ...	·09	·13	Trace	·16
Sulphur, S ...	·11	·15		·18
Hygroscopic Water, H_2O ...	·05	·21	·29	·10
	100·60	100·29	99·31	99·89
Analyst ...	E. S. Simpson.	C. C. Williams.	E. S. Simpson.	E. S. Simpson.

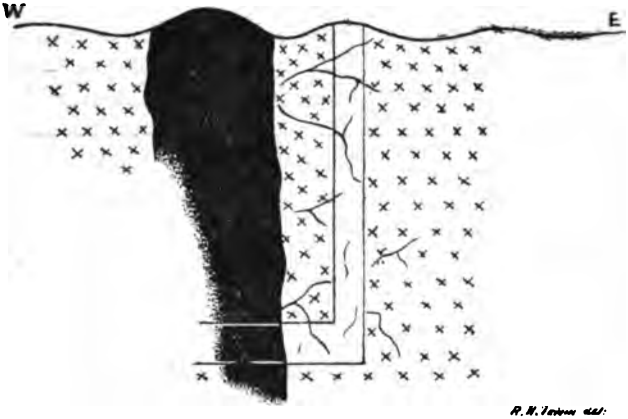
4426.—Felspar porphyry. Mount Catherine Range, Trig. W 19, Yerilla, North Coolgardie Goldfield.

4419.—Transmuted granite. Wallaby G.M.L. 581R. Yarri, North Coolgardie Goldfield.

4417.—Coarse diorite. Yarri, North Coolgardie Goldfield.

4425.—Diabase. Mt. Malcolm, Mt. Margaret Goldfield.

WALLABY NORTH G.M.L. 579R.—Near the southern end of the lease a vertical shaft has been sunk through granite to a depth of 60 feet, and from the bottom a drive has been put in for a distance of 10 feet, at which point the reef opened in the adjoining lease on the south was met with. The reef has been pierced for a distance of 14 feet, and at the date of my visit the whole thickness had not been ascertained. The reef had a slight underlie to the east.



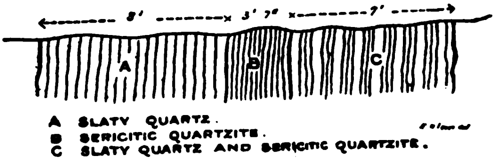
SECTION OF REEF IN THE WALLABY NORTH G.M.L.579R

Fig. 2.

The country rock between the shaft and the reef is permeated with quartz leaders, which vary from ¼in. to ½in. in thickness; some of these are said to contain more or less gold. In the shaft are a few veins of quartz intersecting the granite.

In June, 1903, 21 tons of ore from this lease yielded 21·80ozs. of gold, being at the rate of 1·04ozs. per ton.

Wallaby Central G.M.L. 580R.—The reef worked in lease 579R enters the Wallaby Central, and traverses the whole length of the property. At 285 feet from the southern boundary of 580R, a trench has been put in across the reef, and exposes a width of 24 feet of quartz. One hundred feet from the trench is another 18 feet in width, showing the following section:—



SECTION IN WALLABY CENTRAL G.M.L. 580R

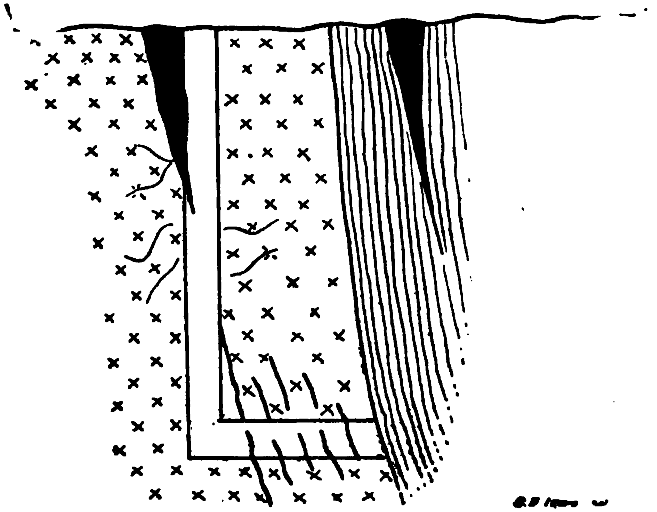
Fig. 3.

Distant 181 feet from the first-mentioned trench is a shaft 91 feet deep. The shaft, which has a slight underlie, has been put down on the foot-wall of the reef. Several leaders are passed through in the shaft. The owners of the property intend opening out on the reef when a depth of 100 feet has been attained.

Near the southern end of the lease a shaft has been put down to a depth of 35 feet, which, at the date of my visit, was inaccessible.

WALLABY G.M.L. 581R.—Upon this lease there are four distinct lines of reef outcropping, three of which traverse the whole length of the property from north to south. Operations at the date of my visit were confined to the easternmost reef, upon which three shafts had been sunk, known respectively as No. 1 shaft, Turner's, and No. 2 shaft.

The following section is exposed in No. 2 shaft, which is 418 feet from the north boundary of the lease:—

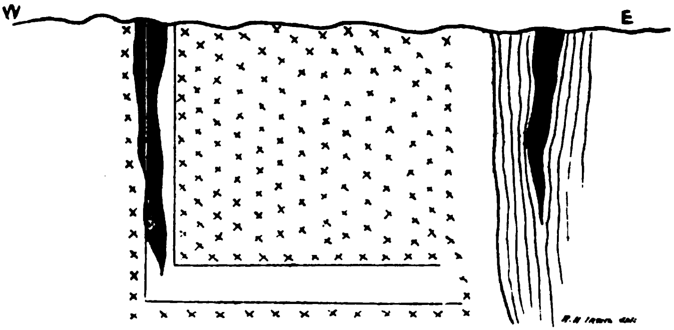


SECTION OF REEF IN N°2 SHAFT WALLABY G.M.L.581R

FIG. 4.

The shaft had been sunk to depth of 77 feet from the surface in granite. The bold reef peters out at a depth of 22 feet from the brace. From the foot of the shaft a crosscut has been carried 36 feet eastward, through a rudely foliated granite with quartz leaders along the planes of foliation; the crosscut has been carried along a joint for the whole distance.

What is known as Turner's shaft is situated 226 feet from No. 1 shaft. The shaft had been carried down to a vertical depth of 60 feet. The following section is exposed in the shaft:—



SECTION IN TURNER'S SHAFT WALLABY G.M.L. 581R

Fig. 5.

From the foot of the shaft a crosscut has been put for a distance of 65 feet, through nothing but transmuted granite, traversed by quartz leaders, running in all directions. The drive is said to be practically barren, assays yielding no gold. At the face of the crosscut the country rock is getting much harder, and carries a little pyrites. At the date of my visit the face of the crosscut was about 20 feet from the middle reef. Five feet north of Turner's shaft is what is known as No. 3 costeen, exposing 42 feet of quartz; 150 feet further south is No. 2 costeen, in which eight feet of quartz have been opened up; and 161 feet further is what is known as No. 1 shaft. This shaft has been sunk to a vertical depth of 55 feet; from the foot a crosscut goes to the east for a distance of 34 feet. The crosscut has been carried through transmuted granite, intersected by quartz veins ramifying in all directions; these, however, are said to carry no gold.

A costeen of 42 feet in length has been opened up 129 feet south of No. 2 shaft; it exposes 42 feet of quartz, which, however, only extends to a depth of three feet below ground. This crosscut is 325 feet from the southern boundary of the lease. The reef opened up extends along the surface for a distance of 900 feet within the boundary of the lease, and can be traced along the surface to the south through leases 582, 591, 587, and 585.

Wild Dog G.M.L. 582R.—Two shafts have been put down on the lease. The easternmost shaft has been put down on the underlie for a short distance, but very little stone is showing. The westernmost shaft is 25 feet in depth, and has been put down between two reefs, which are about 35 feet apart. From the foot of the shaft a crosscut has been put in to the west for a distance of 16 feet.

Just at the mouth of the crosscut a quartz reef of about one foot in thickness was encountered, whilst at the face a little quartz is showing; but, from what can be seen, it does not appear to be very thick. The stone is said to assay from 17 to 18dwts. of gold to the ton. The eastern crosscut has been continued for a distance of 19 feet through nothing but transmuted granite of the usual type.

Record G.M.L. 587R.—The boundary between the granite and the diabase runs through the centre of this lease. The ground has been exploited by means of a vertical shaft 37 feet 6 inches in depth, and situated near the south-eastern angle of the lease.

The shaft has been sunk in decomposed diabase, and from the foot a drive has been put in to the west for a distance of 14 feet through nothing but country rock. The western drive, eight feet in length, traverses similar country. From a point 45 feet distant from the shaft, a costeen 199 feet in length has been opened out to the west, with the object of exposing the country. The deepest part of the costeen is four feet. No reef was located in the trench.

A crushing of 16·50 tons of stone from this lease during June, 1903, yielded 33·31ozs. of gold, being at the rate of 2·02ozs. per ton.

Queen's Birthday G.M.L. 585R.—A shaft has been sunk alongside the reef to a vertical depth of 50 feet. The reef, which is about 11 feet thick at the outcrop, trends practically north and south. The stone is a glassy quartz, of the nature which seems characteristic of the reefs in the diabase country of this district; the stone carries a little iron pyrites. It is intended to put in a crosscut at the foot of the shaft to intersect the reef at that depth.

.A trial crushing of 10 tons from this reef during 1902 yielded gold at the rate of 23ozs. 18dwts. to the ton of quartz. The official records show that 33 tons were crushed during the early part of 1903 for 105·00ozs., being at the rate of 3·18ozs. per ton.

Queen's Birthday South G.M.L. 614R.—Towards the northern end of the lease a shaft had been put down to a vertical depth of about 48 feet. At the foot of the shaft there is about one foot of quartz of the usual type showing. Near the southern boundary of the lease is a shallow prospecting shaft about 24 feet deep; but, beyond a few irregular quartz stringers, no reef appears to have been met with in sinking.

Sixty tons were crushed from this lease during April, 1903, for 39·87ozs. of gold, being at the rate of ·66ozs. per ton.

Novitiate G.M.L. 630R.—A shaft has been sunk vertically through diabase country for a depth of 27 feet 6 inches. At 22 feet is a small quartz leader; from the foot of the shaft a drive goes east about 15 feet, and exposes a quartz vein of about six inches, dipping to the east at an angle of 45 degrees.

19·25ozs. of gold were obtained from specimens from this mine during 1902.

Wise Step G.M.L. 641R.—A vertical shaft had been put down to a depth of 37 feet 6 inches through diabase country. The owners of the property contemplate continuing the shaft to a depth of 80 feet with the object of intersecting the reef, which outcrops at 44 feet from the shaft, by means of a western crosscut.

Beatrice G.M.L. 632R (376E).—Upon this property there are five distinct quartz veins outcropping; several shafts have been sunk, and a fair amount of work carried out.

On what may be called the main reef two shafts have been sunk about 155 feet apart. The northernmost shaft, No. 1, has only attained a vertical depth of 23 feet. At the south end of the shaft there are about 6 to 18 inches of quartz showing. At about 10 feet from the surface a fair amount of work has been done, and a good deal of stone taken out. A drive has been put in about 15 feet to the south; just where the drive leaves the shaft about a foot of quartz is exposed, and at the face a like thickness of glassy quartz. From this shaft about 14 tons of quartz crushed about 18dwt. to the ton at the Neta battery at Edjudina. The south, or No. 2, shaft has a vertical depth of 37 feet. The reef exposed is vertical. From the outcrop, near the shaft, about 50 ounces of gold have been dollied by the previous holders of the ground some years ago. At the southern end of the shaft a drive has been put in for about 10 or 12 feet, and at the face about two feet of quartz is showing. Eighteen inches of quartz is showing at the north side of the shaft. About 50 feet north of the shaft the reef has been worked from the surface down to a depth of about 20 feet by the previous holders of the ground.

What is known as the western reef lies some distance from the one last described. Its position is fixed by the following bearings:—No. 1 shaft, 89°; No. 2 shaft, 127°. This reef has been worked by the previous owners of the property. A shaft has been put down to a depth of about 34 feet, on a slight easterly underlie. From the foot of the shaft a drive 10 feet north shows:—

Diabase; quartz, three inches; formation, eight inches; quartz, nine to ten inches; diabase. At the south end of the shaft the following is exposed:—Diabase; quartz, six inches; formation, six inches; quartz, 14 inches; diabase.

About 80 feet to the west of this is another, which has just been opened on the surface; no work has been done upon it. Sixty feet east of the main reef is another parallel vein having a width of from 12 to 13 feet, as shown on the surface. Beyond laying bare the stone no further work has been done.

The following are the official returns from this lease:—

BEATRICE G.M.L. 622E.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1902	14·00	13·10	0·93
1903 to 30th June ...	24·00	21·31	0·89
Total	38·00	34·41	0·91

To the south of this lease is a claim (not shown on the map) held by Messrs. Byers and Co. An underlie shaft has been put down to the east, at an angle of about 45 degrees, for a distance of 15 feet. The shaft had been sunk upon a vein of about five inches in thickness, which, however, had petered out at the foot of the shaft. The country rock is diabase of the type prevailing in the district.

A traverse from Yarri to Mount Walbrook (W 9) showed the staple formation, after getting clear of the granite, to consist of greenstone schists, and the large quantity of quartz *débris* with which the surface was strewn in places seemed to indicate that there must be quartz veins associated with the schists.

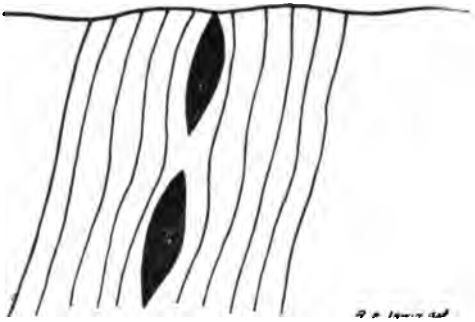
Mount Walbrook consists of a ridge of laminated quartzite, striking 333°. The quartzite is about 8 to 10 feet thick, and is vertical; it carries a little brown hematite of the usual type.

The granite of Yarri gives place to greenstone schist as the mining centre of Edjudina is approached.

EDJUDINA.

The mining centre of Edjudina is of interest in that a virtually continuous line of reefs has been proved to extend in a north-west and south-east direction for a distance of about 10 miles, and has been worked more or less along the whole line. The width of the belt embracing the auriferous quartz reefs nowhere exceeds 20 chains.

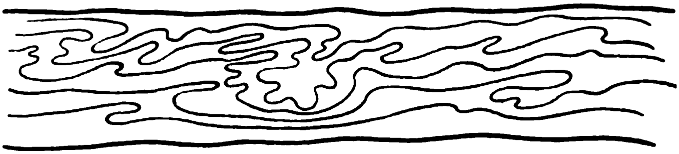
So far as may be seen the reefs consist of exceptionally lenticular veins of quartz occurring along the planes of foliation of the schist, thus :—



SECTION SHEWING THE MODE OF OCCURRENCE OF THE EDJUDINA QUARTZ REEFS.

Fig. 6.

About two miles to the north-east, and parallel to the auriferous quartz reefs, is a long razor-backed ridge formed of the laminated hematite-bearing quartzites (cherts ?) which can be followed for about 15 miles in the vicinity of Edjudina. The width of this belt of laminated quartzite is about 15 chains, and it is made up of a series of remarkably attenuated lenses, each of great horizontal extent. Several bands of quartzite occur within a few chains on either side of the auriferous quartz reefs, and can be followed with very little interruption along the known extent of the auriferous series. Wherever these quartzites can be seen in sections, they are either vertical or are inclined at high angles to the north-east, no lower dip than 68° having been observed. The ridge upon which Yabboo Hill (E 36) is situated extends for about five or six miles, and is made up of three bands of hematite quartzite. The band upon which the trig. station has been built is the most ferruginous. The central band is about 10 to 15 feet thick, and very much contorted thus :—



CONTORTED HEMATITE QUARTZITE
YABOO HILL

Fig. 7.

The quartzites are all enclosed in a slaty cleaved rock, of a nature which it is impossible to determine owing to the extensive surface decomposition it has undergone. The rock, however, has the appearance of being a bleached greenstone schist. The southern end of the ridge disappears gradually into the low ground to the south. The summit of Yabboo Hill (E 36) is by aneroid 200 feet above the trig. station E 35 at Edjudina soaks.

The laminated quartzites range from an almost pure quartz, through varieties of beautifully banded jaspers, to what appears to the eye to be a practically pure hematite.

Table II. gives analyses of six typical varieties of the Edjudina iron ores.

TABLE II.

Analyses of Iron Ores from Edjudina (by E. S. Simpson).

Geological Museum Number.	4401.	4402.	4403.	4404.	4406.	4408.
Metallic Iron, Fe	37·38	25·86	26·69	33·45	38·33	22·85
Silica, SiO_2	45·05	60·82	59·55	51·76	43·10	61·19
Sulphuric anhydride, SO_3	·08	·067	·096	·085	·062	·092
Phosphoric anhydride, P_2O_5	·10	·138	·082	·100	·147	·198
Hygroscopic Water, H_2O	·17	·12	·05	·11	·12	·23
Combined Water, H_2O ...	·49	·87	·74	1·08	·93	4·24
Action on compass	None	None	Strong	None	None	None

4401—Banded hematite, E36, Yabboo Hills, Edjudina, N. Coolgardie G.F.

4402—Banded hematite quartzite, Yabboo Hills, Edjudina, N. Coolgardie G.F.

4403—Banded quartzite with hematite and magnetite, Cairn C., Yabboo Hills, Edjudina, N. Coolgardie G.F.

4404—Banded hematite, Cairn C., Yabboo Hills, Edjudina, N. Coolgardie G.F.

4406—Banded hematite, Hill B., Yabboo Hills, Edjudina, N. Coolgardie G.F.

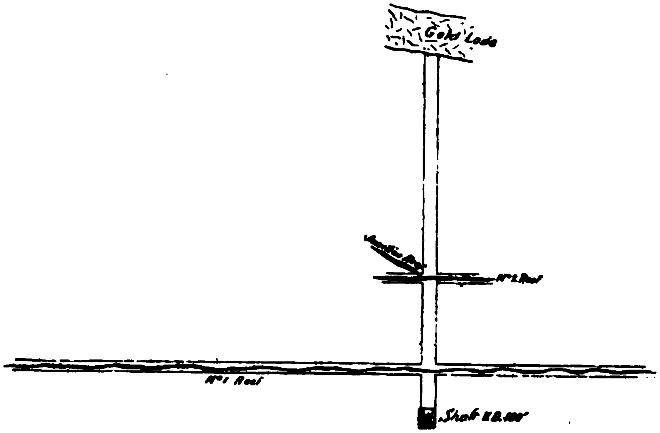
4408—Ferruginous quartzite, Hill A., Edjudina, N. Coolgardie G.F.

These analyses demonstrate that, contrary to the appearance of the ores themselves, they all contain a high percentage of silica and a relatively low percentage of iron. With the single exception of the last (4,408), they could be readily concentrated to high-grade ores. Although the percentage of sulphur is low, the phosphorus would seem to be too high for what is considered a requisite for the production of steel by the usual acid Bessemerprocess.

The following is a description of such of the mines along the Edjudina line as were open to inspection:—

NETA G.M.L. 401E (361E).—The Neta lease is being worked by a vertical shaft 100 feet deep, and two levels have been opened out. From the foot of the shaft a crosscut goes west for a distance of 21 feet to what is known as No. 1 reef, upon which most of the work on the property has been concentrated.

The reef has been opened out to the southward for a distance of 200 feet at the 100 feet; the quartz is of the usual irregular type. Thirty-nine feet to the west of No. 1 reef is another known as No. 2, but at the date of my visit not much work had been done on it. One hundred and six feet further west is what is known as the "Gold lode," 20ft. 4in. in width. The "lode" is merely a band of decomposed country rock intersected by very thin veins of quartz and ironstone.



SKETCH PLAN OF THE NETA MINE G.M.L. 401E

FIG. 8.

At the 50-feet level No. 1 reef is 22 feet from the shaft; 47 feet further west of it is No. 2 reef. In the crosscut, at 50 feet from the shaft, are two or three veins of quartz separated by narrow bands of a foliated sericitic rock.

The reef worked in this property can be followed northwards along the surface through leases 411 and 412.

The official records show that up to the close of 1902 3,202·5 tons of ore from this mine yielded 4,918·39ozs. of gold, as follow:—

NETA G.M.L. 401E (361E).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1898	584·00	751·50	1·28
1899	1,165·50	1,549·49	1·32
1900	380·00	1,022·10	2·69
1901	145·00	318·20	2·19
1902	928·00	1,277·10	1·37
1903 to 30th June ...	811·00	1,004·80	1·23
Total	**4,013·50**	**5,923·19**	**1·47**

Senate G.M.L. 539R.—The reef opened up in the Senate is in all probability the same as the Neta. The Senate reef has been worked by a vertical shaft 113 feet deep, situated close to the southern boundary of the lease.

At the foot of the shaft the reef has been opened up by a drive put in 120 feet to the north and 200 feet southwards. At the face of the northern drive about six to eight inches of quartz is exposed, but the average width is about 18 inches. To the face of the southern drive the reef is continous, with some interruptions, but is very thin.

The official records show that 524·9ozs. of gold were obtained during 1902 by crushing 259 tons of ore, being at the rate of 2·02ozs. per ton.

Gawler G.M.L. 497R (365E): The main shaft on this property is 100 feet deep. From the foot of the shaft a drive has been put in about 200 feet, which shows about one foot of quartz at the face. At about 170 feet from the shaft is a quartz lens of about three feet in thickness, but no great horizontal extent. The north drive has been carried about 200 feet, but at the date at which the mine was visited there was no stone showing in the face.

The official records show that up to the end of 1902 206 ounces of gold were obtained by crushing 130 tons of stone, as follow :—

Gawler G.M.L. 497R (365E).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1901	50·00	88·00	1·76
1902	80·00	118·00	1·47
Total	**130·00**	**206·00**	**1·58**

Fingall G.M.L. 366.—The outcrop of two well-defined reefs traverse practically the whole length of the lease, but at the date of my visit work had evidently been abandoned for many years, and nothing could be seen. There are three shafts on the lease, and all the evidence seems to point to the fact that a good deal of work must have been done on the property.

Welshman G.M.L. 368E (590R) (Louie Mary).—Upon this lease there is only one shaft in which work is going on. The shaft is 50 feet in depth, and operations were being carried out at 12 feet from the bottom. From the bottom of the shaft a crosscut of 120 feet in length, driven on a bearing of S. 50° W., connects with what was the old main shaft. Nothing, however, is showing in the crosscut. East from the shaft there is a small quartz reef exposed, and at the face another of about 8 inches in thickness. The following are the official returns for this lease:—

LOUIE MARY G.M.L. 501R (368E.)

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1900	105·00	230·65	2·19
1901	25·00	30·00	1·20
Total	**130·00**	**260·65**	**2·00**

VULCAN G.M.L. 369E (667R).—No work was being carried out on the lease, and the shaft being inaccessible no description of the deposit can be given. From the material lying in the dump, it may be conjectured that the country rock encountered in sinking is greenstone schist of the usual type. A few yards west of the western boundary of the lease the surface is covered with fragments of hematite-quartzite of the type prevailing on the ridge to the west of the Neta battery. In all probability this band is the continuation of that which is virtually continuous as far as the Old Edjudina and Glengarry mines to the south.

The following returns have been recorded from this lease:—

VULCAN G.M.L. 667R (369E.)

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1900	90·00	58·05	·64
1901	160·00	126·30	·79
Total	**250·00**	**184·35**	**·73**

GOLDEN GIRL G.M.L. 370E (588R).—There is a line of shafts along the reef on the western boundary of the property, but these were inaccessible to me. The following are the official returns from this area:—

LORD NELSON G.M.L. 512R (370E).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1900	50·00	62·50	1·25
1901	188·00	167·20	·89
Total	**238·00**	**229·70**	**·96**

GOLDEN GIRL G.M.L. 588R (370E).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1902	21·00	21·70	1·03
1903 to 30th June ...	40·00	67·50	1·69
Total	61·00	89·20	1·46

ENTERPRISE G.M.L. 589R (371E, 604R).—Previously called **BIG BEN** (506R). Four quartz reefs of the prevailing type traverse the lease. A well-defined reef traverses the eastern boundary of the lease, which has been opened up in several places, and a good deal of stone raised from a depth of about 10 feet. In an open cut about five feet of quartz is exposed. The reef can be followed, with a few interruptions, to the southern boundary, where it enters the adjoining lease at 126 feet from the south-east angle of 371. An open cut about 60 feet in length exposes a good thickness of quartz of the prevailing type. At the boundary between G.M.L.'s. 371 and 372 the reef has pinched out to about two inches. A maximum thickness of about four feet of quartz is now visible in the open cut, which in its deepest part attains a depth of 13 feet.

A little distance to the west of the open cut a shaft about 20 feet in depth was, at the date of my visit, being sunk by the holders of the ground. The shaft was sunk in greenstone schist, with the object of following down a very small quartz leader.

The main shaft has been sunk to a vertical depth of 80 feet. From the foot of the shaft the reef has been driven on for a distance of 200 feet north, at which point it pinched out. A crosscut 24 feet in length connects with another shaft to the east. This shaft is 80 feet in depth, and has been carried down through greenstone schist of the prevailing type. The reef in the first-mentioned shaft has been driven on for a distance of about 100 feet in a southerly direction. At the face of the drive there are about 12 inches of quartz showing; it contains small quantities of carbonate of iron. The maximum width of quartz in the south drive is three feet six inches. The reef, however, is of lenticular habit, lens succeeding lens, being connected by threads of quartz.

Near the northern boundary of the lease a shaft has been put down to a depth of about 10 feet, with the object of prospecting two reefs about four feet six inches apart. The foot-wall reef is about from six to eight inches thick, and the hanging-wall vein three to four inches.

The following crushings have been recorded from this lease:—

BIG BEN G.M.L. 506R AND ENTERPRISE G.M.L. 589R.

Year.	Ore crushed.	Gold therefrom	Rate per ton.
	tons.	ozs.	ozs.
1900	30·00	9·00	·30
1903 to 30th June ...	22·00	13·00	·59
Total	**52·00**	**22·00**	**·42**

HEATHCOTE G.M.L. 372.—No work was going on at the date of my visit, and the main shaft had been partly filled up. A good deal of quartz is lying round the mouth of the shaft. In 1900, 72 tons of stone were crushed for 38ozs. gold, being at the rate of ·53oz. per ton.

M.A. 3 lies within what was originally known as G.M.L. 373. A deep shaft, at present inaccessible, occurs on this ground, but no particulars are obtainable in connection with it. There are also the remains of an old three-head battery, said to have been erected for crushing the dumps left by the previous holders of the ground.

ECLIPSE G M.L. 373.—A vertical shaft is at present being sunk; and at the date of my visit had attained a depth of 30 feet. The shaft was put down with the object of intersecting a reef outcropping a little distance to the west.

PERSEVERANCE G.M.L. 374 (613R).—There are two shafts on the lease; the southernmost is inaccessible; the northern is 73 feet deep. The reef, which occurs along the foliation planes of greenstone schist, has a maximum thickness of three feet six inches The reef has been opened up by drives 50 feet in length on the north, and a similar length to the south. The quartz is the usual bunchy lenticular type.

The official records show that during 1902 24 tons of stone were crushed for a yield of 40ozs. of gold from this lease, being at the rate of 1·66ozs. per ton.

THREE BROTHERS G.M.L. 383 (599R).—There are three reefs on this property. The most northerly shaft (1), sunk on the line of the largest reef, was inaccessible; hence no description of the workings can be given.

The western shaft (2), sunk on the middle reef, had been put down to a depth of 75 feet, and a drive 18 feet to the south had been opened out. There was only an inch or two of quartz, dipping at an angle of 68 degrees to the east. Shaft (3), situated in the south-east angle of the lease, was inaccessible.

The fourth shaft, situated about 80 feet south of No. 2, had been carried down to a depth of 75 feet vertically below the surface.

From the foot of the shaft drives had been put in north and south along the reef. The northern drive is about 30 feet in length, and shows 16 inches of quartz at the face.

Scotchman G.M.L. 384 (566R).—There are two lines of reef outcropping on this lease, and they are continuous throughout the whole length of the property, and extend as far to the southward as G.M.L. 274E.

The following are the official returns from this lease:—

SCOTCHMAN G.M.L. 566R (384E).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1902	131·00	112·50	·86
1903 (to 30th June) ...	110·00	77·25	·70
Total	**241·00**	**189·75**	**·79**

G.M.L. 274E.—A good deal of work has been done on this lease, and a fair quantity of stone raised; but at the date of my visit the workings were inaccessible, hence little could be seen.

G.M.L. 273E.—A well-defined quartz reef outcrops along the western boundary of the lease. The reef, as exposed in a trench, is about 32 feet thick.

Try It G.M.L. 272E (665R).—What is probably the same reef as that outcropping in the adjoining lease on the north traverses this property, but very little work has been done upon it.

During the early part of 1903, 21 tons of ore from this lease yielded 9·08 ounces of gold, being at the rate of ·43 ounces per ton.

G.M.L. 271E.—A quartz reef of about three feet in thickness makes a bold outcrop at a point about 55 feet from the north-west angle of the lease, and a shaft, now inaccessible, has been put down on it. At about 200 feet from the south-east angle there is an excavation about six feet in depth.

G.M.L. 270E.—There are three parallel reefs traversing this property. Near the south-west angle of the lease is a line of old and inaccessible shafts put down along the strike of the westernmost reef. Parallel to this, and close to the north-eastern boundary of the lease, is another equally persistent line of reef, which has been opened up by open cut along its strike. The stone is of the character prevailing in the district, and occurs in the form of lenses enclosed in a casing of sericite schist.

Bella G.M.L. 275E (609R).—There are three distinct lines of reef traversing the lease, the eastern and western being those which extend from the adjoining ground in the north.

A vertical shaft 50 feet in depth was being sunk at the date of my visit. On the northern face of the shaft the quartz reef attained a thickness of three feet. Gold was shewing freely in the stone lying at grass. A good deal of work had been done by the previous holders of the ground. The official statistics show the following crushings from this lease:—

Bella G.M.L. 275E (609R).

Year.	Ore Crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1900	64·00	105·70	1·65
1901	160·00	200·00	1·25
1903 (to June 30th)...	206·50	212·50	1·03
Total	**430·50**	**518·20**	**1·20**

Crow's Nest G.M.L. 277E (576R).—The reef worked on this property is the same as that opened out in the Bella, to the north. The present working shaft, near the northern boundary of the lease, is 30 feet deep, and shows 3ft. 6in. of quartz at the foot.

The adjoining shaft to the north, 80 feet distant on the same reef, has been put down to a depth of 50 feet; and the stone has been stoped out to the surface. The reef has been driven on for about 120 feet. There are about 160 tons of quartz lying at grass, some of which shows gold freely.

A good deal of work seems to have been carried out along the outcrop of a reef outcropping close to the south-western boundary. This reef extends into the adjoining lease to the south.

The following crushings are recorded from this lease:—

Crow's Nest G.M.L. 576R.

Year.	Ore Crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1902	55·00	63·00	1·14
1903 (to 30th June)...	112·00	160·00	1·43
Total	**167·00**	**223·00**	**1·33**

G.M.L. 276.—The reef has been worked by means of a vertical shaft, which was inaccessible to me. Judging from the paddock of stone lying at grass, the reef must have been about 2ft. 6in. thick in places.

Parallel to this reef, and about 470 feet east, is another, which makes a characteristically bold outcrop on the surface. The width of the reef is about three feet six inches, but although it can be followed for a considerable distance along the outcrop, it does not appear to have been much worked.

G.M.L. 321.—A shaft has been sunk to a vertical depth of 25 feet, and a quartz reef of about two feet six inches in thickness exposed.

Triumph G.M.L. 322E (605R).—The most southerly shaft on the lease was at work at the date of my visit. The reef opened up on the adjoining property on the north can be followed through the lease on a bearing of 147 degrees. Parallel to this reef is another to the east, upon which work was being carried on at the date of my visit. The vertical shaft had attained a depth of 35 feet. The reef is practically vertical, though with a perceptible underlie to the east. The reef is of the usual lenticular character. The easternmost shaft on the property had been carried down to a depth of 20 feet; the country rock has a slight dip to the east. On the foot wall of the reef is a very thin band of platey fissile quartzite. Adjoining this shaft on the north, and on the same line of reef, another shaft had been carried down to a depth of about 50 feet, and about 35 feet of stoping done on either side of the shaft. At the foot of the shaft the country rock underlies east at an angle of 65 degrees. About 50 tons of ore have been raised from this reef.

Old Edjudina Mine G.M.L. 323E (623R).—A deep shaft, now inaccessible, apparently passed through little else than what appears to be a sericite schist. In the dump were several pieces of stone, showing irregular patches of quartz, encased between the laminae of the schist. The quartz contained a little iron pyrites and iron carbonate, and is evidently, as seems to be the case with most of the reefs, in the form of lenticules along the planes of schistosity. Judging by the size of the dump and the numerous small shafts, a good deal of work must have been done at one time or another.

Glengarry G.M.L. 493E (502R).—The main shaft on the lease had been carried down to a depth of about 150 feet. At 75 feet the reef had been opened up, and stoped out to the surface. Judging by the open cuts on the surface, a fair amount of work must have been carried out. The mine being practically under water, very little was to be seen of the nature and character of the reef. During 1901, 395ozs. of stone were crushed for 243·50ozs. of gold, being at the rate of ·68ozs. per ton.

The Edjudina belt of hematite-bearing quartzites are continuous northwards across Lake Reside through Mounts Millicent W15, and Howe W14.

GOLD YIELD OF THE EDJUDINA DISTRICT.

Year.	Ore Crushed.	Gold therefrom.	Rate per ton.
Aerie G.M.L. 655R.			
	tons.	ozs.	ozs.
1903 (to 30th June) ...	38·00	55·00	1·44

GOLD YIELD OF THE EDJUDINA DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom	Rate per ton.
ALPHA G.M.L. 681R.			
	tons.	ozs.	ozs.
1903 (to 30th June) ...	**20·00**	**16·70**	**·83**
ANGLO SAXON G.M.L. 204R.			
Previous to 1898 ...	**28·00**	**23·50**	**·84**
BEATRICE G.M.L. 622R.			
1902	14·00	13·10	·93
1903 (to 30th June) ...	24·00	21·31	·88
Total	**38·00**	**34·41**	**·90**
BELLA G.M.L. 527R.			
1900	64·00	105·70	1·65
1901	160·00	200·00	1·25
1903 (to 30th June) ...	206·50	212·50	1·03
Total	**430·50**	**518·20**	**1·20**
BIG BEN G.M.L. 506R.			
1900	**30·00**	**9·00**	**·30**
BRILLIANT G.M.L. 513R.			
1901	**30·00**	**57·55**	**1·92**
BROKEN HILL G.M.L. 610R.			
1902	40·00	35·70	·89
1903 (to 30th June) ...	35·00	19·30	·55
Total	**75·00**	**55·00**	**·73**
BROKEN HILL NORTH G.M.L. 611R.			
1903 (to 30th June) ...	**17·00**	**4·86**	**·28**
CHEETARRA G.M.L. 676R.			
1903 (to 30th June) ...	**25·00**	**2·11**	**·08**

Gold Yield of the Edjudina District—*continued.*

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
Concordia G.M.L. 545r.			
	tons.	ozs.	ozs.
1902	**28·00**	**9·40**	**·33**
Crow's Nest G.M.L. 576r.			
1902	55·00	63·00	1·14
1903 (to 30th June) ...	112·00	160·00	1·43
Total	**167·00**	**223·00**	**1·33**
Enterprise G.M.L. 589r.			
1903 (to 30th June) ...	**22·00**	**13·00**	**·54**
Eva G.M.L. 522r.			
1902	29·00	57·00	1·96
1903 (to 30th June) ...	29·00	57·00	1·96
Total	**58·00**	**114·00**	**1·96**
Gawler G.M.L. 497r.			
1901	50·00	88 00	1·76
1902	80·00	118·00	1·47
Total	**130·00**	**206·00**	**1·58**
Glengarry G.M.L. 502r.			
1901	**359·00**	**243·50**	**·68**
Golden Girl G.M.L. 588r. (late Lord Nelson G.M.L. 512r.)			
1900	50·00	62·50	1·25
1901	188·00	167·20	·89
1902	21·00	21·70	1·03
1903 (to 30th June) ...	40·00	67·50	1·69
Total	**299·00**	**318·90**	**1·06**
Heathcote G.M.L. 503r.			
1900	**72·00**	**38·00**	**·53**

GOLD YIELD OF THE EDJUDINA DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
HIGHLAND MARY G.M.L. 573R.			
	tons.	ozs.	ozs.
1902	46·00	52·50	1·14
LOUIE MARY G.M.L. 501R.			
1900	105·00	230·65	2·20
1901	25·00	30·00	1·20
Total	130·00	260·65	2·00
LYON GLEN G.M.L. 677R.			
1903 (to 30th June) ...	84·00	108·70	1·29
MAID MARION G.M.L. 653R.			
1902	17·00	13·00	·76
MT. EIVERSLEY G.M.L 460R.			
1899	55·00	61·00	1·11
NETA G.M.L. 401R.			
1898	584·00	751·50	1·28
1899	1,165·50	1,549·49	1·33
1900	380·00	1,022·10	2·69
1901	145·00	318·20	2·19
1902	928·00	1,277·10	1·37
1903 (to 30th June) ...	811·00	1,004·80	1·24
Total	4,013·50	5,923·19	1·47
NETA EXTENDED G.M.L. 418R.			
1899	104·00	118·18	1·13
1900	622·50	681·90	1·09
1901	456·00	863·70	1·89
Total	1,182·50	1,663·78	1·40
NINETY-NINE G.M.L. 459R.			
1899	30·00	10·45	·35

GOLD YIELD OF THE EDJUDINA DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
OUTCAST G.M.L. 523R.			
	tons.	ozs.	ozs.
1900	30·00	41·60	1·38
1901	30·00	29·00	·97
Total	**60·00**	**70·60**	**1·17**
PERSEVERANCE G.M.L. 613R.			
1902	**24·00**	**40·00**	**1·66**
QUEEN'S BIRTHDAY G.M.L. 585R.			
1903 to 30th June ...	**33·00**	**105·00**	**3·18**
QUEEN'S BIRTHDAY SOUTH G.M.L. 614R.			
1903 to 30th June ...	**60·00**	**39·87**	**·66**
RECORD G.M.L. 587R.			
1903 to 30th June ...	**16·50**	**33·31**	**2·02**
RETURN G.M.L. 680R.			
1903 to 30th June ...	**25·00**	**16·50**	**·66**
ROCKY RIDGE G.M.L. 679R.			
1902	**8·00**	**10·30**	**1·29**
SCOTCHMAN G.M.L. 566R.			
1902	131·00	112·50	·86
1903 to 30th June ...	110·00	77·25	·70
Total	**241·00**	**189·75**	**·79**
SENATE G.M.L. 539R.			
1902	**259·00**	**524·90**	**2·02**
TRIUMPH LEASES, LTD., G.M.L.s 13/8R, 244/5R, 308R.			
Previous to 1898 ...	1,747·00	1,648·00	·94
1898	515·00	565·30	1·09
Total	**2,262·00**	**2,213·30**	**·97**

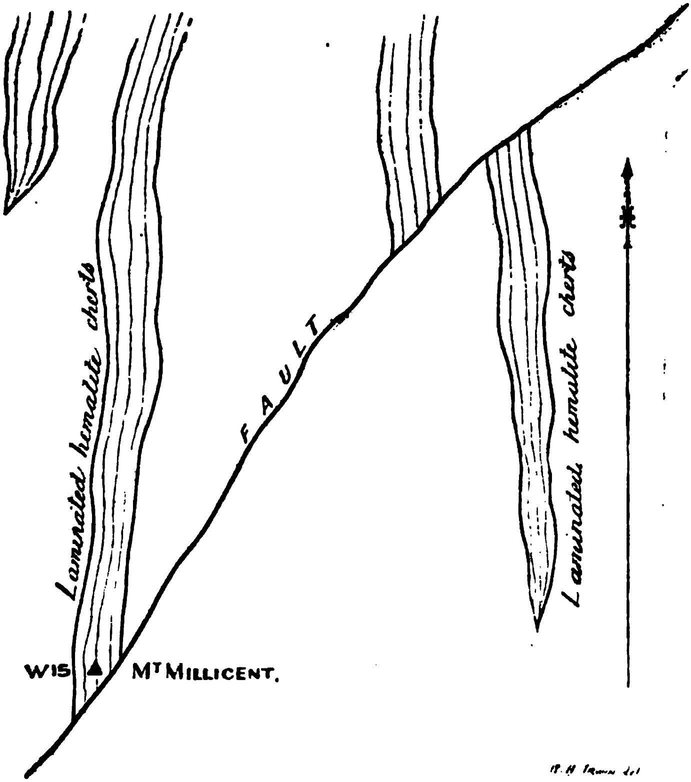
GOLD YIELD OF THE EDJUDINA DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
TRY-IT G.M.L. 665R.			
	tons.	ozs.	ozs.
1903 to 30th June ...	**21·00**	**9·08**	**·43**
UNDAUNTED G.M.L. 510R.			
1901	**65·00**	**64·35**	**·99**
VULCAN G.M.L. 498R.			
1900	90·00	58·05	·64
1901	160·00	126·30	·79
Total	**250·00**	**184·35**	**·73**
WALLABY NORTH G.M.L. 579R.			
1903 to 30th June ...	**21·00**	**21·80**	**1·04**
SUNDRY CLAIMS AT EDJUDINA.			
1899	75·00	72·30	·96
1900	57·00	54·52	·95
1901	381·00	352·14	·92
1902	283·00	338·30	1·19
1903 to 30th June ...	32·00	105·00	3·28
Total	**828·00**	**922·26**	**1·11**

Mount Millicent (Reedy's Bluff) rises to a height of about 450 feet above the level of the surrounding country. The quartzites (4633, 4634) of the summit present all the usual gradations between a practically pure quartz rock, through beautifully ribboned jaspers to a laminated hematite quartzite. As is the case at Edjudina, the belt is formed of two or three bands of quartzite, at varying distances apart, one band lying about two miles to the east of the main belt. The highest ridge of the Mount Millicent group is formed of a brecciated form of the hematite quartzite; the brecccia (fault rock) being formed of angular fragments of quartzite, jasper, and hematite, cemented together by secondary silica. Many of the bands are minutely puckered and contorted between their walls, though it is only occasionally that their place is taken by breccias. All the available evidence seems to indicate that these lines or bands of quartzite have been formed along sheer planes, and that faulting took place subsequently to the deposition of the iron ores themselves.

At the summit of Mount Millicent the hematite quartzites are very highly contorted and puckered, and have a dip of, in one place, 65 degrees to the north-east.

In addition to movement along the line of the quartzites, a section in the vicinity of Mount Millicent shows an excellent example of the sudden truncation of a quartzite band, by a vertical fault bearing 124 degrees. The contorted quartzite ends abruptly in a perfectly smooth wall, about 10 or 20 feet in height, and is shifted to the west for several feet. This fault, which is shown in the accompanying section, is probably responsible for the truncation of the band which forms Mount Millicent.



R. H. Brown del

PLAN OF NEIGHBOURHOOD OF MT. MILLICENT

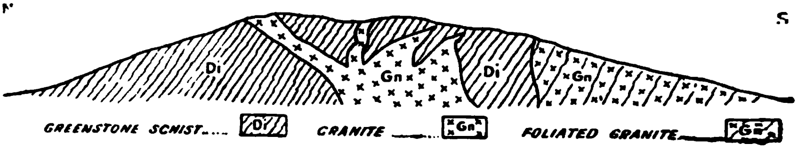
NOT TO SCALE

Fig. 9.

Somewhat similar brecciated and contorted hematite quartzites are continuous to Mount Howe, W14, which rises, according to aneroid measurements, to an altitude of about 500 feet above the surrounding country. The belt has a general strike of 163 degrees, and is continuous for about 10 miles to the north, where it is crossed by the main road from the Quartz Blow Soaks to Linden. Here the quartzites are encased in a decomposed slatey rock, which there are good grounds for believing to be merely bleached forms of the greenstone schists which make up the country on either flank of the ridge.

West of Mount Howe (W14) is Mount Percy (E67), which rises to a height of 530 feet above the level of the plains.

A low though conspicuous rise about five miles east of Mount Percy, and bearing 308 degrees therefrom, shows a section which seems to demonstrate the relation which the granite rock bears to the greenstone and allied basic rocks.



SECTION NEAR MT PERCY

FIG. 10.

This low rise is made up of greenstone, which has been rudely foliated or cleaved, along a bearing of 119 degrees. This has been invaded by dykes of a fine-grained granite rock (4636). Near the northern end of the rise the surface is occupied by a foliated granite, the strike of the foliation planes being parallel with those of the neighbouring greenstone. This section is of importance in that it seems to indicate that there are granites of two totally distinct geological ages in the district.

Mount Percy (E67) forms one of the highest summits of a fairly extensive series of hills, drained by numerous gullies, which all discharge their waters into Lake Raeside. The mount, as well as the whole of the hills, is formed of diabase (4637), intersected by dykes of granite of the usual type. These dykes, doubtless, emanate from that extensive mass of granite which extends from Yundamindera to Quartz Blow Soaks, and Mount Catherine.

LINDEN.

The mining centre of Linden, at present practically at a standstill, lies about eight or nine miles to the east of the Edjudina and Camel Back Soak belt of iron-bearing quartzites. The productive centre lies just along the junction of the greenstones and allied rocks with the granite, which may form part of the Quartz Blow Soak mass.

Mount Linden (W8), which rises to 140 feet above the plains, is formed of bands of ferruginous quartzite (4626), striking 320 degrees and dipping north at an angle of about 50 degrees. The quartzite (chert?) is seamed with veins of secondary silica.

The following are the particulars of such of the properties as were open to inspection at the date of my visit:—

Great Carbine G.M.L. 406r.—This property is situated some distance to the south of Mount Linden and beyond the limits of the Mines Department lithograph L28.

The reef, which has been worked, has a strike of 267 degrees and underlies to the north at a high angle. A vertical shaft has been sunk to a depth of 50 feet; on the eastern face of the shaft, and at the foot, there is a quartz reef about two feet in thickness exposed. This reef has been worked for about 50 feet along the strike; at the western face of the drive there is about 18 inches of quartz. The reef has been practically all stoped out to the surface from the 50 feet level.

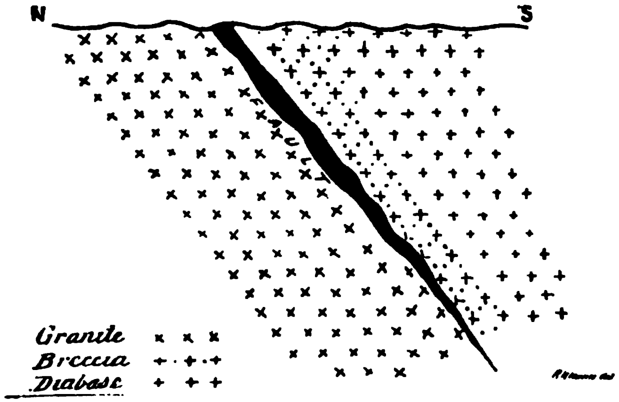
Free gold can be seen in some of the quartz, in addition to a little pyrites. From this reef 294 tons of quartz crushed have been officially reported as yielding 178·2 ounces of gold, as follows:—

Great Carbine G.M.L. 406r.

Year.	Ore treated.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1898	36·00	42·70	1·18
1899	5·00	7·25	1·45
1900	253·00	128·25	·50
Total	294·00	178·20	·60

Golden Ridge (Federal) G.M.L. 3314.—This property was not at work at the date of my visit, and had evidently been abandoned for some considerable time.

As seen on the surface, the strike of the reef is north 60° east. The reef occurs along a faulted junction of granite and diabase, which underlies to the south at 51 degrees. The reef, which is not very thick, has been worked for some distance on the underlie. The granite foot wall shows well-marked slicken-sided faces trending in the direction of the underlie of the reef. The hanging wall of the reef is a brecciated diabase. Gold is showing in the stone.



SECTION OF THE GOLDEN RIDGE REEF G.M.L.3314.

Fig. 11.

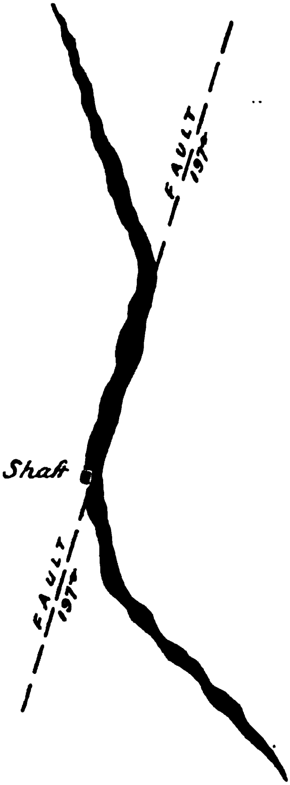
The following are the official returns from this lease:—

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1898	10·00	6·95	·69
1899	26·25	†166·23	6·33
1900	52·75	*69·15	1·31
1901	18·60	40·30	2·16
Total	107·60	282·63	2·62

† Includes 13·98ozs. dollied and specimens. * Includes 2·25ozs. dollied and specimens.

G.M.L. 4240.—No work was going on at the date of my visit to the property. A quartz reef enters the lease on its southern boundary at a point about 160 feet from the south-east angle of the property, on a bearing of 327 degrees. The reef has been opened up by a shaft of unknown depth. A good deal of stone has been raised, and is now lying at grass, but so far as a casual inspection went no gold could be seen in any of it.

The following is a plan of the reef:—



PLAN OF REEF IN G.M.L. 4240

Fig. 12.

Further to the north, along the line of reef is an east and west costeen in which two reefs have been exposed. The reefs, which underlie to the westward, are about 20 feet apart, and lie parallel to the one opened up in the southern shaft.

The northernmost shaft is also inaccessible. A quartz reef, bearing 127 degrees, passes through it. This reef has an underlie of 48° to south 60° west.

G.M.L. 4241.—The greater portion of this lease lies in Lake Carey, which extends much further to the south than is shown on the existing litho. L28. Although this lease lies within the boundary of the lake it is not covered with any material thickness of alluvium, for the underlying greenstone schists crop out in the floor of the lake.

Near the north-west angle of the lease is a quartz reef bearing 263° which has been opened up by former holders of the ground. The reef, which underlies to the north, has a thickness of about two feet.

G.M.L. 4237.—Near the north-east angle of the property, which is situated on the western shores of the southern end of Lake Carey, is a quartz reef of 18 inches in thickness, with a strike of 42°, and underlying at a high angle to the north.

At a point bearing 42° from the north-east angle of the lease, and about 250 feet therefrom, the small 18-inch reef is joined by a larger one of six feet six inches, having a strike of 333°. This reef has a considerable horizontal extent, and disappears in the adjoining lease to the north. It gradually peters out northward, but its place is taken by another parallel reef, the outcrop of which lies a few feet to the east, and the strike of which is 335°. The figures below show the relation of these reefs to one another:—

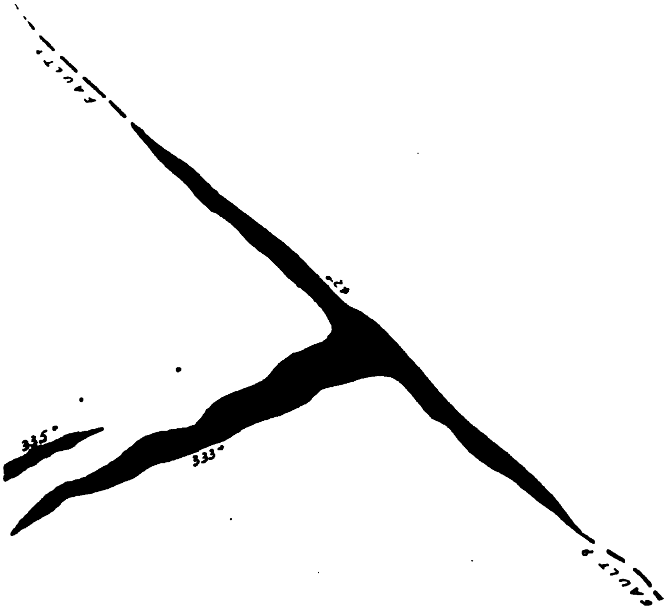


Fig. 13.—Plan of Reefs in G.M.L. 4237.

G.M.L. 4236.—The easternmost reef mentioned above as occuring in the adjoining property on the north passes through this lease and disappears beneath the surface of the lake not far from the southern boundary of G.M.L. 4235.

No work of any consequence appears to have been done on this reef.

Mt. Wilgress G.M.L. 357r.—This lease forms the centre of a group of five, trending northwards from the north-eastern corner of the proclaimed boundary of the Linden townsite.

A main shaft has been put down on the northern brow of a relatively low ridge, which trends north-west and south-east, but owing to the abandonment of the property, acccess to the workings is not possible.

A few feet west of the shaft a bluish white quartz reef, underlying to the east, outcrops, and a fairly large reef outcrops a few feet to the east. The western reef has an average strike of 131° 30′, and the eastern 148 degrees.

From the cubical cellular spaces in the western reef, it is evident that the quartz contains a reasonable proportion of pyrites at a depth; this reef, as measured on the suface, is about three feet in thickness and underlies eastward at 61°.

Returns show that in 1897 nine tons of stone from this lease were crushed for 7·50 ounces of gold, equal to ·83 ounces per ton.

G.M.L. 286.—A reef bearing 153½ degrees outcrops at some distance to the east of that last mentioned. This reef has been opened up for about a chain along its outcrop to a depth of about 20 feet. So far as could be judged from the surface, the reef has a thickness of about two feet.

GOLD YIELD OF THE LINDEN DISTRICT.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
Blair Athol G.M.Ls. 188r, 196r.			
	tons.	ozs.	ozs.
1899	104·00	278·80	2·68
1900	9·00	117·00	13·00
1901	. .	*11·17	...
Total	**113·00**	**406·97**	**3·60**

* Plates and extras.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
Burgess Luck G.M.L. 399r.			
1898	27·00	*520·00	19·25
1899	...	†7·83	...
Total	**27·00**	**527·83**	**19·55**

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* Includes 460ozs. dollied and specimens. † Dollied.

Gold Yield of the Linden District—*continued.*

Caledonian G.M.L. 413R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1898	25·00	27·75	1·11
1899	48·00	23·73	·49
Total	**73·00**	**51·48**	**·70**

Crushed Tragedian and True Blue G.M.Ls. 286R, 285R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
1897	19·00	*41·35	2·17
1898	19·00	28·10	1·47
Total	**38·00**	**69·45**	**1·83**

* 18ozs. dollied.

Federal G.M.L. 464 (late Golden Ridge G.M.L. 123R).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
1898	10·00	6·95	·69
1899	26·25	*166·23	6·33
1900	52·75	†69·15	1·31
1901	18·60	40·30	2·16
Total	**107·60**	**282·63**	**2·62**

* Includes 13·98ozs. dollied and specimens. † Includes 2·25ozs. dollied and specimens.

Great Carbine G.M.L. 406R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
1898	36·00	42·70	1·18
1899	5·00	7·25	1·45
1900	253·00	128·25	·50
Total	**294·00**	**178·20**	**·60**

Greenhills G.M. Co., G.M.L. 408R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
1898	40·00	185·50	4·64
1899	1,314·00	2,689·90	2·04
1900	1,676·00	2,566·95	1·53
1901	168·00	811·75	4·83
1902	...	181·40*	...
Total	**3,198·00**	**6,435·50**	**2·01**

* From tailings by cyaniding.

GOLD YIELD OF THE LINDEN DISTRICT—*continued.*

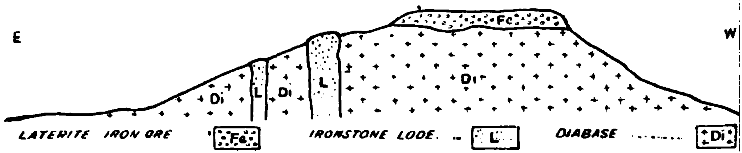
Year.	Ore crushed.	Gold therefrom.	Rate per ton.
KANGAROO G.M.L. 414R.			
	tons.	ozs.	ozs.
1898	18·05	9·25	·51
LADY EDITH G.M.L. 484R.			
1898	69·00	243·60	3·53
1899	105·50	451·00	4·27
Total	174·50	694·60	3·98
LADY ETHEL G.M.L. 387R.			
1898	252·00	293·55	1·16
1899	295·25	524·95	1·77
1900	239·00	384·40	1·60
1901	30·00	20·05	·66
Total	816·25	1,222·95	1·49
LAKE VIEW AND BOULDER EAST G.M. CO., G.M. LEASES 188R, 196R, 384R, 123R, 320R.			
1897	522·00	810·75	1·55
1898	61·00	34·20	·56
Total	583·00	844·95	1·44
MOUNTAIN MAID G.M.L. 430R.			
1898	3·50	4·10	1·17
MT. WILGRESS G.M.L. 357R.			
1897	9·00	7·50	·83
NEW YEAR'S GIFT G.M. CO., G.M.L. 407R.			
1899	164·00	112·00	·68
1900	12·00	11·00	·91
Total	176·00	123·00	·69
RECOVERY G.M.L. 468R.			
1899	8·00	51·85	6·48

GOLD YIELD OF THE LINDEN DISTRICT—*continued.*

Yield.	Ore treated.	Gold therefrom.	Rate per ton.
TRAVELLERS JOY G.M.L. 420R.			
	tons.	ozs.	ozs.
1898	37·00	46·55	1·25
1899	18·00	24·50	1·36
1900	16·00	36·00	2·25
Total	**71·00**	**107·05**	**1·50**
TRUE BLUE JACKET G.M.L. 295R.			
1897	**12·00**	**18·60**	**1·55**
WIMMERA G.M.L. 358R.			
1897	22·00	56·60	2·57
1898	85·00	136·16	1·61
1899	145·50	185·30	1·27
1900	120·00	* 179·27	1·49
1901	44·00	52·60	1·19
Total	**416·50**	**609·93**	**1·46**
PORTSEA G.M.L. 188R.			
1898	**76·00**	**51·52**	**·67**
SUNDRY CLAIMS AT LINDEN.			
1899	68·75	96·80	1·40
1900	112·75	149·40	1·32
1901	46·00	40·50	·88
1902	11·00	11·50	1·04
Total	**238·50**	**298·20**	**1·25**

* Includes 4·20ozs. dollied and specimens.

The country in the vicinity of Linde Mia (Pindinnie Soak) Reserve 5214, is all granite, of the usual type. This granite is intersected with several large quartz reefs which stand out in bold relief, and make prominent marks in the landscape, the most pronounced of these being that at the Quartz Blow Soaks Reserve 5580, distant about eight miles south-east of Linde Mia. This reef has a general strike of 115 degrees. To the west of Linde Mia, and about three miles distant, is another similar reef, which rises to an altitude of about 50 feet above the surrounding country, outcropping for a distance of about a quarter of a mile, on a bearing of 79 degrees. The quartz is pure white and destitute of mineral of any kind. Below Linde Mia and the almost deserted mining centre of Eucalyptus, granite occupies the country as far as Old Joe's Soak, Reserve 6561. A short distance to the east of the soak, and on the south side of the road, is a small hill which exposes an interesting section, shown below:



SECTION ACROSS LATERITE HILL NEAR JOE'S SOAK

FIG. 14.

The summit of the hill is formed of a thin capping of pisolitic iron ore (4639), which may possibly conceal an ironstone lode. Lower down the eastern slope of the hill are two vertical ironstone lodes (4640), about two feet in thickness in diabase. These have their outcrops partially decomposed into pisolitic iron ore, similar in character to that capping the summit of the hill. On the face of the ridge is a scree or talus of weathered iron ore, which bids fair to become in time a pisolitic iron ore also.

A little further to the east, the Eucalyptus road surmounts a low tableland of laterite, which occupies the country within a short distance of the diggings.

YUNDAMINDERA (THE GRANITES).

The auriferous reefs of Yundamindera occur along the eastern boundary of the belt of granite (4643) which extends from Lake Raeside northwards. Some portions of the granite have a rude foliation, and contain lenticular patches of what may be correctly described as micaceous schist (4644). Some of the quartz reefs, from their laminated nature, have evidently undergone a certain amount of crushing since their formation.

Very little in the way of mining was going on at the date of my visit, but the following is a brief description of such of the properties as were open to inspection:—

Landed at Last G.M.L. 443e (Potosi Co.).—The outcrop of what may be called the main reef strikes north-west and south-east, and underlies to the N. 35° E. at 32 degrees. The reef has been opened up by an underlie shaft from 130 feet to 150 feet in length, from which two levels have been driven. In No. 1 level the quartz is of a characteristic laminated type. No. 2 level, which has been driven 120 feet to the north, shows an irregular body of laminated quartz, encased in a coarse, micaceous granite of the type prevailing in the district; to the southward the level has been driven for a distance of 35 feet. At the foot of the underlie the width of the reef between the walls is five feet.

Parallel to this reef on the east, and distant about 51 feet, is another one of a similar character, which underlies at the same angle and in the same direction, but very little work appears to have been done upon it.

The official returns from this mine show that, during the years 1899 and 1900, 60 tons of quartz yielded 82·05 ounces of gold, as follows:—

LANDED AT LAST G.M.L· 443R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1899	37·00	44·05	1·19
1900	23·00	38·00	1·65
Total	**60·00**	**82·05**	**1·36**

GREAT BONAPARTE G.M.L. 480R (POTOSI Co.).—An east and west reef underlying to the north at an angle of 50° has been opened out at 80 and 90 feet, but no work was going on at the date of my visit. The reef is an irregular rock-bound quartz vein, enclosed in granite of the usual type. The manager of the property, Mr. Kidd, informs me that on careful sampling the stone yielded no values.

MAORI QUEEN G.M.L. 541R.—The reef on this property is one which extends to the south-east, and traverses the two adjoining leases. The reef can be followed along the surface for over half a mile. There are three shafts on the lease. The northernmost shaft has been sunk for a distance on the underlie of a reef which is of the usual type, enclosed in granite. At the foot of the shaft drives have been put in north and south, and expose a variable thickness of quartz of the usual type. The country on both the hanging and the foot wall side of the reef has been explored by crosscuts, but nothing but granite laid bare.

The central shaft has been carried down to a vertical depth of 150 feet, but owing to the water the mine was inaccessible below the 100 feet level.

At 75 feet a level has been driven to the south-east for a distance of 100 feet, but at the face no quartz is showing. A crosscut of 10 feet in length has been put in to the north-east, and a drill-hole eight feet further in from its face, which exposed nothing but granite of the usual type. The section in this drive shows that the reef occurs along a fault fissure. Northwards from the shaft a drive has been put in for a distance of 40 feet, and a crosscut 16 feet to the south-west has intersected a quartz reef of about two feet six inches in thickness.

At 100 feet from the surface a drive has been put in 90 feet northwards, but at the date of my visit this was inaccessible, but is said to have exposed three or four inches of quartz of the usual type. To the south the level has been driven 75 feet. A crosscut 20 feet in length has been put in in an east-north-east direction, and intersected a thin quartz reef, and another a few feet further in.

This mine makes water at the rate of 3,000 gallons per diem.

The southern shaft had at the date of my visit attained a depth of 15 feet; it was contemplated continuing it until the reef met within the adjoining shaft to the north had been intersected.

The following are the yields from this lease:—

MAORI QUEEN G.M.L. 541R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1901	70·00	125·00	1·78
1902	290 00	582·50	2·01
Total	**360·00**	**707·50**	**1·96**

TREASURE EAST G.M.L. 493R.—The reef opened out in the Maori Queen extends throughout the whole length of the property, and a good deal of work has evidently been carried out. At the date of my visit to the mine water was standing up to No. 2 level. The mine is capable of yielding water at the rate of 150,000 gallons per diem. Along No. 2 level there is about an average of two feet of quartz exposed. Some crushings have been taken out of this mine, but owing to the fact that they are included with those from the other leases (443, 457, and 463) held by the London and Hamburg Gold Recovery Company, the exact yield of the stone from this lease cannot be given.

PRETORIA G.M.L. 511R.—There are three shafts on this property, all of them put down upon the reef opened out in the two adjoining properties on the north. There is not very much to be seen at the present time in the workings.

The most noteworthy shaft has been sunk 10 feet vertically to the reef, thence down the underlie 140 feet to the north-east, the reef showing all the way down the shaft. At the 90 feet level a drive has been put in 50 feet northerly and thence 70 feet southerly.

The central shaft on the same reef had been carried down 50 feet, through granite of the usual type. From the foot of the shaft a crosscut has been put in to the west, which, at a point 15 feet from the mouth, passed through four inches of quartz dipping to the north-east. A western crosscut exposes at 23 feet from the shaft a quartz reef of two feet in thickness, underlying to the north-east.

The most southerly shaft is inaccessible.

From the official records it appears that during the years 1901 and 1902 55 tons of quartz yielded 56·05ozs. of gold, as follows:—

PRETORIA G.M.L. 511R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1901	35·00	32·85	·93
1902	20·00	23·20	1·16
Total	55·00	36·05	1·02

POTOSI G.M.L. 450R.—The Potosi property has been worked by an underlie shaft. The reef has been worked to within about 25 feet from the surface from No. 1 level. There being no adequate plan of the property, a full description of the workings cannot be very well given.

Number 1 level has been driven north 420 feet and south 120 feet along the reef; number 2 level has been driven north 200 feet and south 49 feet. At this point the reef is only six inches in thickness. Number three level has been carried north 165 feet along the reef, which at the face is two feet six inches in thickness. The shaft has been continued 115 feet below number 3 level, and shows four feet of quartz.

The returns for this lease are included with those of the Mount Margaret Reward Claim, Ltd.

QUEEN OF THE MAY NORTH G.M.L. 524R.—There are three abandoned shafts on the property, but all are inaccessible. So far as may be judged by the dumps, the country rocks passed through is a foliated granite of the type prevailing in the district.

QUEEN OF THE MAY G.M.L. 466R.—There are three shafts on this lease. The most northerly shaft, which is now inaccessible, has been carried down 140 feet on an eastern underlie. This shaft had been sunk upon a reef which strikes N. 35° W. The shaft is used for the purpose of supplying water to meet the requirements of the Potosi Gold Mining Company. The mine yields water at the rate of between 6,000 and 7,000 gallons per diem.

As seen in the shaft down to 100 feet level, the reef consists of a zone of sheared granite, with thin veins of quartz parallel to the planes of schistosity. At a depth of 80 feet from the mouth of the shaft a crosscut has been put in to the east for about 30 feet through a pseudo-foliated granite. At 100 feet drives have been put in to the north and south for a distance of 100 feet each way.

The central shaft has been carried down to a depth of 110 feet; at 80 feet the reef consists of a very fissile and platey quartz. The water standing in this shaft is lowered by continued pumping in the ground to the north.

The southern shaft has been carried down to a vertical depth of 60 feet through granite country, but no reef has been discovered therein.

Crushings have been recorded from this mine during the years 1899, 1900, 1901, 1902, totalling 675·6 tons, with a yield of 658·2ozs. of gold, as follows:—

QUEEN OF THE MAY G.M.L. 466R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1899	14·60	31·00	2·12
1900	106·00	199·75	1·88
1901	300·00	170·00	·56
1902	255·00	257·45	1·01
Total	**675·60**	**658·20**	**·97**

QUEEN OF THE MAY SOUTH G.M.L. 467R.—The northern shaft on the lease has been sunk to a depth of 20 feet, and a drive has been put in to the south designed to intersect the open cut just alongside the shaft. About eight or nine inches of quartz of a somewhat fissile type is showing in the drive.

The central or water shaft has been carried down 100 feet vertically; at 90 feet a drive has been extended 80 feet northwards: in it there is about an average of 15 inches of quartz showing. About five feet of potable water is standing in the shaft. The southern shaft, which has been sunk on the same reef, has been carried down to a depth of 40 feet. From the foot of the shaft a drive has been put in along the reef to the north and connects with another shaft 38 feet in depth. At about 20 feet from the northern end of the drive is about 12 inches of platey fissile quartz of the usual type. About half way up this intermediate shaft the total width of the reef and formation is from 2 feet 6 inches to 3 feet. There have been officially recorded from this mine 1,191 ozs. of gold as the result of crushing 566·55 tons of quartz, as follows:—

QUEEN OF THE MAY SOUTH G.M.L. 467R.

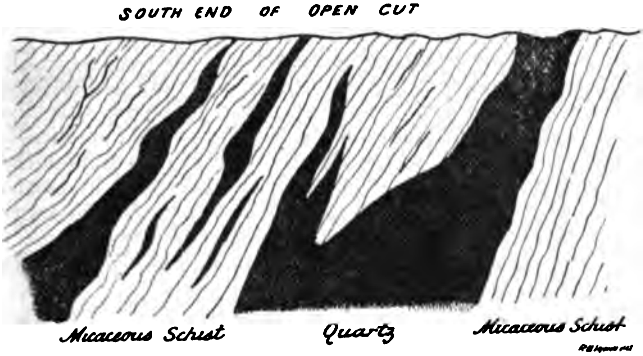
Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1899	16·55	33·00	1·99
1900	156·00	321·90	2·06
1901	231·00	666·00	2·37
1902	113·00	171·00	1·51
Total	**566·55**	**1,191·90**	**2·10**

PINDINNIE DEEP G.M.L. 463R.—This lease adjoins that last mentioned on the east. A vertical shaft has been put down (to an unknown depth) at the north-west angle of the lease through a micaless granite (4643). There is a little quartz of a very fissile type lying at grass; some of the quartz contained ribbons of felspar, suggesting the possibility of the quartz being merely a transmuted pegmatite vein. No work was going on at the time the lease was visited, hence a description of the workings cannot be given.

In 1900 the official records show that a crushing took place, but as it is included in the total of 125 tons yielding 157·6ozs. from the four leases 443, 457, 463, and 493, it is impossible to arrive at the exact amount of gold returned from this property.

G.M.L. 490R.—On this lease there is an underlie shaft 10 feet in depth, exposing a laminated quartz reef dipping at 41° to N. 60° E. The country rock on both the hanging and the foot walls is foliated granite of the usual type.

LITTLE WONDER G.M.L. 522R (a new lease embracing G.M.L. 461, Woomera).—An open cut 5 feet deep at the north-west angle of the lease shows the following section :—



SECTION OF REEF IN G.M.L.522.

FIG. 15.

The quartz is enclosed in a micaceous schist, which may merely represent a transmuted granite.

At the northern end of the open cut, which is about 21 feet in length, there is only one foot of quartz exposed. The general strike of the quartz is south-east, and the underlie to the north-west at about 50 degrees. A fair quantity of quartz is lying at grass.

There are several shafts on the property and a good deal of work done, but, owing to the want of accurate plans of the workings, a definite description thereof is well nigh impossible. The reef is fairly well defined and naturally varies greatly in its size.

The returns for these two leases are as follow:—

WOOMERA G.M.L. 461R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1899	58·00	28·85	·49
1900	10·90	12·85	1·18
Total	**68·90**	**41·70**	**·60**

LITTLE WONDER G.M.L. 522R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1901	82·00	284·00	3·46
1902	197·00	839·86	4·26
Total	**279·00**	**1,123·86**	**4·02**

BOER G.M.L. 508R (originally Rich View, 462R).—This is a six-acre lease adjoining the south-east boundary of that last mentioned. A great deal of work has been done on this lease by previous holders of the ground, and the reef worked practically from the surface. The reef is a rockbound vein of quartz underlying at an angle of 45° to the east, and has been intersected by two vertical shafts, one 20 feet and the other 50 feet deep. At the foot of the 50 feet shaft the reef is about 12 inches in thickness. Coarse gold and pyrites is showing in a specimen (4646) from the foot of the 50 feet shaft.

A little distance to the south another shaft upon the same reef has been put down to a depth of 25 feet, but it only exposes about an inch or two of quartz.

According to the official figures several good crushings have been recorded from the lease, as follows:—

RICHVIEW G.M.L. 462R AND BOER G.M.L. 508R.

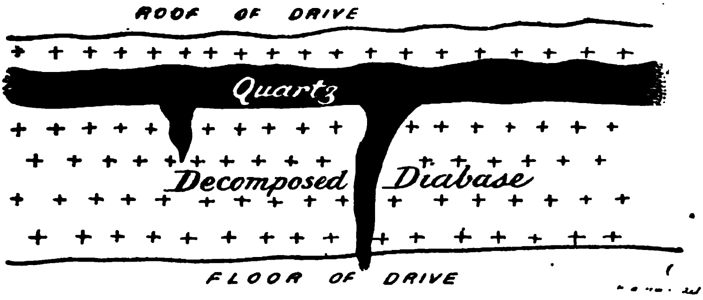
Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1900	74·00	226·80	3·06
1901	137·00	357·50	2·61
1902	62·00	207·00	3·33
Total	**273·00**	**971·30**	**2·89**

PENNYWEIGHT POINT.

The mining centre of Pennyweight Point lies east of Yundamindera, and due north of the trig. station (⩚7208) on Mt. Keith. There were only about four or five men at work at the date of my visit, hence very little could be seen. A good deal of dry-blowing must have been carried out at one period in the history of the district. The surface of the ground is covered with a shallow deposit of surface loam, beneath which is a relatively small thickness of aluminous laterite (? bauxite, 4642). The country rock seems to be diabase of the prevailing type.

The following is a description of those workings of which it was possible to make an inspection :—

Lombard G.M.L. 3349 (305R).—A vertical shaft 25 feet in depth had been put down near the northern boundary of W.R. 12 adjoining. This shaft exposes about three feet of laterite, which passes without abrupt line of demarcation into the underlying country. A drive has been put in from the bottom of the shaft for a short distance to the north-east; about 12 feet in the drive is a quartz reef underlying to the north-west at a low angle. The western side of the drive shows the following section :—



SECTION OF REEF IN G.M.L. 3349.

Fig. 16.

No work appears to have been carried out by the present occupants of the ground. The surface of the lease, however, is studded with numerous old abandoned shafts, giving silent testimony to the activity which at one time evidently prevailed.

Highland Chief G.M.L. 568R.—The Highland Chief workings are situated on the slope of a diabase hill, bearing 32° from W.R. 14R, and distant about a mile and a-half. The outcrop of the reef, which runs almost due east and west, can be followed for a considerable distance along the surface, and had apparently been opened up by previous occupants of the ground. The only accessible shaft at the date of my visit had been carried down to a vertical depth of 85 feet. At the foot was an east and west quartz reef underlying to the north at an angle of 55°. The reef had been opened out by drives put in to the east and west for a distance of

10 feet each way; in the eastern face the quartz reef attained a thickness of 3 feet 6 inches, and 1 foot 6 inches in the western. Free gold was showing in the quartz, which carried a small quantity of green carbonate of copper on the faces. At a vertical depth of 40 feet, the reef had been opened up 17 feet to the east, and a distance unknown to my informant, on the west. A crushing reputed to have yielded 29dwts. is said to have been obtained from this level. At the 20 feet level, a crushing is said to have averaged 16dwts. This property, which seems to have a good future before it, labours under the difficulty of having to cart the stone to Yundamindera, some miles distant, at a cost of 8s. 6d. per ton, and a charge for crushing rate varying from 25s. to 30s. per ton.

A.W.A. G.M.L. 562R.—The A.W.A. reef lies in close proximity to the Highland Chief. As seen on the surface the outcrop trends 109°. The property has been opened up by means of a vertical shaft sunk along the reef 90 feet deep.

Washington G.M.L. 594R.—The Washington is a reef upon which a good deal of work has been done at one time or another, but the workings were inaccessible at the date of my visit. The reef trends generally east and west, and underlies to the north. At the present time a deep shaft is being put down, and at the date of my visit had attained a depth of 115 feet. A crosscut is being put in to the south, at a depth of 100 feet, with the object of intersecting the reef at that depth. At the date of my visit the crosscut had only been driven 15 feet from the shaft. So far as may be judged by the stone in the outcrop, the stone of the Washington reef is free milling ore.

The following table shows the various crushings from these properties :—

GOLD YIELD OF THE YUNDAMINDERA DISTRICT.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
A.W.A. G.M.L. 562R.			
	tons.	ozs.	ozs.
1901	25·00	22·47	·89
1902	165·00	762·30	4·62
1903 to 30th June ...	20·00	29·00	1·45
Total	**210·00**	**813·77**	**3·87**
Boer G.M.L. 508R (late Rich View G.M.L. 462R).			
1900	74·00	226·80	3·06
1901	137·00	357·50	2·61
1902	62·00	207·00	3·34
Total	**273·00**	**791·30**	**2·90**

GOLD YIELD OF THE YUNDAMINDERA DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
BOUND TO RISE G.M.L. 117R.			
	tons.	ozs.	ozs.
Previous to 1897	Unknown	240·00	...
1897	·05	39·00	780·00
Total	...	**279·00**	...
BOOMERANG G.M.L. 533R.			
1901	52·00	58·70	1·12
1902	69·00	69·95	1·01
Total	**121·00**	**128·65**	**1·06**
DEWEY G.M.L. 487R.			
1900	**134·45**	**240·10**	**1·78**
GEORGE WASHINGTON G.M.L. 111R.			
1897	10·00	27·63	2·76
1898	72·75	173·40	2·38
1899	22·00	35·50	1·61
Total	**104·75**	**236·53**	**2·25**
GIOBIA G.M.L. 542R.			
1901	**40·00**	**14·75**	**·37**
HIGHLAND CHIEF G.M.L. 673R.			
1903 to 30th June	**16·00**	**23·10**	**1·44**
GRANITE KING G.M.L. 550R.			
1902	**96·00**	**64·10**	**·66**
JUST-IN-TIME G.M.L. 546R.			
1901	**109·00**	**59·00**	**·54**

GOLD YIELD OF THE YUNDAMINDERA DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
LITTLE WONDER G.M.L. 522R.			
1901	82·00	284·00	3·46
1902	197·00	839·86	4·26
Total	**279·00**	**1,123·86**	**4·03**
LONDON AND HAMBURG GOLD RECOVERY CO.'S G.M.Ls. 443R, 457R, 463R, 493R.			
1900	125·00	157·50	1·26
1903 to 30th June ...	350·00	176·70	·50
Total	**475·00**	**334·20**	**·70**
MAORI QUEEN G.M.L. 541R.			
1901	70·00	125·00	1·78
1902	290·00	582·50	2·01
1903 to 30th June ...	20·00	28·00	1·40
Total	**380·00**	**735·50**	**1·93**
MT. MARGARET REWARD CLAIM, LTD., G.M.Ls. 450R, 456R, 536R.			
1899	76·00	170·00	2·23
1900	109·00	169·65	1·55
1901	4,718·00	3,636·54	·77
1902	2,784·00	2,580·10	·92
1903 to 30th June ...	1,243·00	853·10	·68
Total	**8,930·00**	**7,409·39**	**·83**
POTOSI NORTH EXTENDED G.M.L. 514R.			
	tons.	ozs.	ozs.
1901	116·00	173·50	1·49
1902	131·00	266·05	2·03
1903 to 30th June ...	59·00	118·00	2·00
Total	**306·00**	**557·55**	**1·82**
PRETORIA G.M.L. 511R.			
1901	35·00	32·85	·94
1902	20·00	23·20	1·16
Total	**55·00**	**56·05**	**1·02**

GOLD YIELD OF THE YUNDAMINDERA DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
QUEEN OF THE MAY G.M.L. 466R.			
	tons.	ozs.	ozs.
1899	14·60	31·00	2·12
1900	106·00	199·75	1·89
1901	300·00	170·00	·57
1902	255·00	257·45	1·01
1903 to 30th June ...	260·00	247·00	·95
Total	**935·60**	**905·20**	**·97**
QUEEN OF THE MAY SOUTH G.M.L. 467R.			
1899	16·55	33·00	1·99
1900	156·00	321·90	2·06
1901	281·00	666·00	2·37
1902	113·00	171·00	1·51
Total	**566·55**	**1191·90**	**2·10**
TE ANAU G.M.L. 121R.			
1898	**17·00**	**16·00**	**·94**
TUCKER BAG G.M.L. 499R.			
1900	**7·00**	**95·30***	**13·61**

* Includes 13ozs. dollied and specimens.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
TREASURE NORTH G.M.L. 549R.			
1902	72·00	121·74	1·69
1903 to 30th June ...	36·00	101·23	2·81
Total	**108·00**	**222·97**	**2·06**
WOOMERA G.M.L. 461R.			
1899	58·00	28·85	·49
1900	10·90	12·85	1·18
Total	**68·90**	**41·70**	**·61**
SUNDRY CLAIMS AT YUNDAMINDERA.			
1898	137·00	189·30	1·38
1899	73·00	167·30	2·29
1900	39·00	17·90	·46
1901	30·00	14·30	·48
1902	202·00	418·01	2·06
1903 to 30th June ...	20·00	28·00	1·40
Total	**501·00**	**834·81**	**1·66**

EUCALPYTUS.

This all but deserted mining centre lies due east of Linde Mia (Pindinnie Soak).

A good deal of *bona-fide* work must have been carried out in the neighbourhood at one period of its existence; and so far as may be judged by the state of the surface a good deal of dryblowing must have been done. The productive area is embraced within the limits of about half a mile square. Practically no work was going on at the date of my visit, hence very little was to be seen. The following, however, is a description of those workings which it was possible for me to examine :—

LADY PASCOE G.M.L. 371.—An inaccessible shaft had been put down on a small quartz leader. In 1899, 10 tons from this lease yielded 4·32ozs. of gold, being at the rate of ·43ozs. per ton.

G.M.L. 315 (SHANNON G.M. Co.)—An inaccessible relatively deep shaft had been put down at the south angle of the lease. On the surface at the south side of the shaft, two reefs trending respectively 298deg. and 269deg. outcrop. Very little work would seem to have been done on these. The following returns of the Shannon G.M. Co. were obtained from this lease, and M.A. 2B :—

SHANNON G.M. Co.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1899	164·00	65·50	·39
1900	22·00	60·20	2·73
Total	**186·00**	**125·70**	**·67**

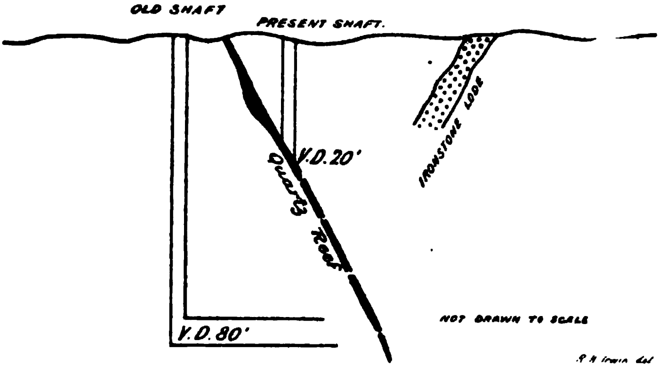
G.M.L. 398.—A water shaft had been sunk to a depth of 130 feet through diabase country, but no water was obtained.

G.M.L. 4480.—A good deal of work has been done upon the reef traversing this piece of ground. The reef first makes its appearance as a fine thread on the summit of the rising ground in the adjoining lease to the south, 367; and can be followed north-westward across the lease in the direction of 398.

Several shallow shafts have been put down at different points along the outcrop, but although some rich pockets have been met with, no serious attempt to systematically open up the reef would appear to have been made.

A vertical shaft, 80 feet in depth, had been put down by previous holders of the ground, apparently on the wrong side of the outcrop of the reef. The present holders of the ground have sunk a shaft 20 feet in depth. About 10 inches of quartz are exposed;

in the footwall is a rubbly ironstone leader, samples from which, in addition to showing coarse, free gold, dollied very well. The ironstone leader, I am credibly informed, has been invariably observed to cut out at from 30 to 40 feet from the surface.



SECTION OF REEF IN G.M.L. 4480

Fig. 17.

Brown Hill Reef.—A little distance south of G.M.L. 385 is what is known as the Brown Hill Reef, which trends generally north-west and south-east. This reef, so far as may be judged by the number of disused shafts, must have been extensively worked by previous holders of the ground. The reef underlies at about one in one to the west; the accessible workings show that the quartz, which nowhere is very thick, occurs along a line of fault, both the hanging and the footwall sides of the vein being strongly slickensided.

About two miles to the north is the Shannon G.M.Ls. 958 and 3372 (Triumph North) which are now abandoned. The reef, which stands boldly out from the surface, forms a prominent landmark, and has a general strike of 35deg. The quartz reef, which is vertical, and several feet thick, is seamed with veins of a siliceous oxide of iron. (4641.)

Nowhere on the surface of the area does the cover of superficial deposits exceed six or eight feet in thickness. From what may be seen in the workings, costeans, etc., it is quite evident that the diabase is intersected by a net-work of quartz veins, in reality an auriferous stock-work, to the residual decomposition of which the rich dryblown patches may be ascribed. The richness of the superficial deposits, as well as the richness of the quartz reefs and leaders, would seem to afford good grounds for somewhat more systematic mining than would hitherto seem to have been in vogue.

The drainage from Eucalyptus flows north-east into Lake Carey, along several well defined water-courses. The rich residual deposits have led to prospecting in these valleys for deep leads, but so far nothing but a thin cover of wash resting upon rock decomposing in situ in the direction of kaolin, has been met with. Between Eucalyptus and the lake some miles distant, the fall is very slight, and hardly sufficient to warrant the inference that the country is likely to develop an extensive system of deep leads.

GOLD YIELD OF THE EUCALYPTUS DISTRICT.

Brown Hill G.M.L. 491r.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1900	7·00	*81·20	11·60
1901	—	†31·91	—
Total	**7·00**	**113·11**	**16·16**

* Includes 22·05ozs. dollied and specimens. † Dollied and specimens.

Cardigan G.M.L. 538r.

1900	7·00	150·00	21·43
1901	6·00	22·85	3·81
Total	**13·00**	**172·85**	**13·29**

Chesapeake G.M.L. 442r.

1899	**10·00**	**7·00**	**·70**

Cornucopia G.M.L. 520r (late 100r Nine of Hearts).

1898	520·00	718·87	1·38
1899	295·00	154·05	·52
1900	61·00	60·50	·99
1901	14·00	3·15	·22
Total	**890·00**	**936·57**	**1·05**

Golden King G.M.L. 530r.

1900	—	*74·60	—
1901	2·00	29·85	14·92
Total	**2·00**	**104·45**	**52·22**

* Dollied and specimens.

Ironsides G.M.L. 426r.

1899	**60·00**	**25·35**	**·42**

Keep-it-Dark G.M.L. 416r.

1898	**24·00**	***204·50**	**8·52**

* Includes 119·50ozs. dollied and specimens.

GOLD YIELD OF THE EUCALYPTUS DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom	Rate per ton.
KNIGHT ERRANT G.M.L. 505R.			
	tons	ozs.	ozs.
1900	12·00	* 70·93	5·91

* Includes 48·60ozs. dollied and specimens.

LADY PASCOE G.M.L. 371R.

1899	10·00	4·32	·43

SCOTCHMAN G.M.L. 477R.

1899	2·35	* 110·70	47·10

* Includes 65·45ozs. dollied and specimens.

SHANNON G.M. CO. G.M.L. 315R AND M.A. 2R.

1899	164·00	65·50	·39
1900	22·00	60·20	2·73
Total	**186·00**	**125·70**	**·67**

UNITY G.M.L. 400R.

1898	20·00	15·00	·75
1900	3·00	6·00	2·00
Total	**23·00**	**21·00**	**·91**

YANDO G.M.L. 504R.

1900	4·00	* 210·20	52·55
1901	15·00	† 974·40	64·96
1902	20·00	‡ 723·61	36·18
1903	—	§ 56·16	—
Total	**39·00**	**1,964·37**	**50·36**

* Includes 175·10ozs. dollied and specimens. † Includes 624·75ozs. dollied and specimens. ‡ Includes 452·86ozs. dollied and specimens. § Dollied and specimens.

SUNDRY CLAIMS AT EUCALYPTUS.

1898	54·00	51·00	·94
1899	104·50	* 453·34	4·33
1900	12·00	† 115·50	9·62
Total	**170·50**	**619·84**	**3·63**

* Includes 332·52ozs. dollied and specimens.
† Includes 67ozs. dollied and specimens.

Leaving Yundamindera my route took me *via* French's Soak (Reserve 3387). The staple formation between the two places being granite of the usual type. About four miles to the north-east of the soak a vein of chalcedony has been opened up on the southern face of a low granite tableland. The matrix of the chalcedony is granite decomposing in the direction of kaolin. Several small veins of a chalcedonic breccia outcrop in the neighbourhood, but only upon one of them does any very great amount of prospecting appear to have been done. The vein is about six to eight inches in thickness, and has been followed down to a depth of about 10 feet. The chalcedony occurs in the form of irregular fragments along a joint or sheer plane. So far anything yet opened up is of little if any commercial value.

About a mile west of French's Soak the granite gives place to diabase (4648) which forms the summit of Mount Kildare, E52.

Between Mounts Kildare and Kilkenny, J.H.R. 19, the country appears to be all diabase. The summit of the latter peak is a fairly coarse-grained gabbro (4649, 4650).

MOUNT MALCOLM.

The Mount Malcolm neighbourhood is situated in diabase and allied rocks. At the date of my visit little or no mining was going on anywhere, and with one exception access to the underground workings was not obtainable; hence no description of the reefs and other cognate points is possible. The attached map shows the position of the various reefs so far as can be seen by careful inspection of the surface, and the following table of statistics shows the gold yields of the various properties.

GOLD YIELD OF THE MOUNT MALCOLM DISTRICT.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	ALICIA G.M.L. 388C.		
	tons	ozs.	ozs.
1897	**20·00**	**40·38**	**2·01**
	DEERAH G.M.L. 406C (631T).		
1898	40·00	172·60	4·31
1899	63·00	224·90	3·57
Total	**103·00**	**397·50**	**3·86**
	DOVER CASTLE G.M.L. 212C (4352).		
1897	40·00	49·17	1·23
1898	119·00	159·73	1·34
1899	213·00	204·76	·96
1900	63·00	23·05	·36
Total	**435·00**	**436·71**	**1·00**

GOLD YIELD OF THE MOUNT MALCOLM DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
DUMBARTON G.M.L. 722c.			
	tons	ozs.	ozs.
1899	25·00	37·25	1·46
1900	111·00	136·55	1·23
1901	52·00	38·07	·73
1902	30 00	18·15	·65
Total	**218·00**	**230·02**	**1·05**
FLYING PIG G.M.L. 452c.			
1897	41·07	243·22	5·92
1898	90·00	152·33	1·69
1899	62·00	189·75	3·06
1900	69·00	120·15	1·74
1901	70·00	103·85	1·48
Total	**332·07**	**809·30**	**2·43**
GOLDEN CROWN G.M.L. 756c (4519).			
1899	52·00	57·20	1·10
1900	247·00	294·95	1·19
Total	**299·00**	**352·15**	**1·17**
GOLDEN PRIZE G.M.L. 33c.			
1898	**17·00**	**21·97**	**1·29**
GOLDEN SUNSET G.M.L. 355c.			
1897	·05	1·35	27·00
1898	186·00	332·72	1·78
1899	15·00	18·00	1·20
Total	**201·05**	**352·07**	**1·75**
GREAT BARRINGTON G.M.L. 568c.			
1898	**19·00**	**8·65**	**·45**
GWALIA BACH G.M.L. 459c.			
1897	30·00	50·10	1·67
1898	10·00	9·30	·93
Total	**40·00**	**59·40**	**1·48**

GOLD YIELD OF THE MOUNT MALCOLM DISTRICT—*continued.*

MAFEKING G.M.L. 773C.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1900	**16·00**	**6·00**	**·37**

MALCOLM BELLE G.M.L. 576C (LATE SUNDAY, 146C).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
1897	28·00	32·93	1·17
1898	54·00	52·20	·96
1899	79·00	71·58	·90
1900	82·50	69·05	·83
Total	**243·50**	**225·76**	**·92**

MT. MALCOLM GREAT NORTHERN REEF G.M.L. 717C.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
1899	**50·00**	**23·00**	**·46**

MIDAS G.M.L., 637C (LATE MALCOLM MOHR, 147C).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
1898	373·50	262·91	·73
1899	433·00	559·26	1·29
1900	370·80	643·05	1·73
1901	303·00	276·72	·91
1902	561·00	396·08	·70
Total	**2,041·30**	**2,138·02**	**1·04**

NORTH STAR G.M.LS. 2C, 3C, 26C (3213).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
1897	3,435·75	3,494·12	1·01
1898	1,144·00	1,197·04	1·04
1899	638·00	706·40	1·10
1900	5,076·00	4,784·15	·94
1901	2,352·00	2,248·25	·95
1902	1,233·00	2,227·07	1·80
Total	**13,878·75**	**14,657·03**	**1·05**

PRIDE OF THE NORTH G.M.L. 385C.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
1897	**5·30**	**54·00**	**10·19**

PIG AND WHISTLE G.M.L. 534C.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
1898	**36·00**	**43·10**	**1·19**

GOLD YIELD OF THE MOUNT MALCOLM DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
PRIMROSE DAY (MIDAS SOUTH G.M.L. 548C).			
	tons.	ozs.	ozs.
1898	13·00	31·55	2·42
1899	17·00	23·30	1·37
Total	**30·00**	**54·85**	**1·82**
RICHMOND G.M.Ls., 12c (1196) 634c.			
1897	16·00	36·35	2·27
1898	1,079·00	1,284·26	1·19
1899	786·00	836·44	1·08
1900	48·00	29·40	·61
1901	...	*cy.* 598·54	...
1902	603·00	459·95	·76
Total	**2,514·00**	**3,244·94**	**1·29**
SOUTH STAR G.M.L. 596c (530K).			
1898	74·00	69·50	·93
1899	59·00	76·60	1·29
Total	**133·00**	**146·10**	**1·09**
SHOTOVER G.M.L. 580c.			
1899	**10·00**	**5·10**	**·51**
WHISPERING HOPE G.M.L. 617c.			
1898	21·00	16·92	·80
1899	53·00	44·28	·83
Total	**74·00**	**61·20**	**·82**
KNARK G.M.L. 946c (770c).			
1902	**27·00**	**10·18**	**·37**
SUNDRY CLAIMS AT MOUNT MALCOLM.			
1898	44·00	61·99	1·40
1899	6·00	12·71	2·12
1900	111·50	81·65	·73
1901	32·00	20·00	·62
1902	429·00	475·21	1·10
Total	**622·50**	**651·56**	**1·04**

SUMMARY.

One of the most noteworthy features in the country under examination is the occurrence of a continuous belt of iron-bearing cherts or quartzites, which has been followed for a distance of not less than fifty miles. There are strong reasons for believing that it extends northwards as far as Mount Morgans. The beds of which the belt is composed range from an almost pure quartz, through banded jaspers, often of great beauty, to what appears to the eye to be practically pure hematite. Analyses of the typical varieties of the different classes of ore showed that, contrary to their general appearance, they all contain a high percentage of silica, and a relatively low percentage of iron. Many of the deposits could readily be concentrated to high grade ores. Although the geographical position of the deposits puts them, under present conditions, beyond the reach of commercial enterprise, there is little doubt that were they more favourably situated as regards proximity to fuel, fluxes, or even water carriage, some of them might be turned to profitable account. Of the origin of the deposits it is difficult, with our present knowledge, to form any precise opinion. They are evidently not of clastic origin, occurring as they invariably do, in the greenstone schists; these have invariably been subject to a great amount of bleaching and decomposition in close proximity to the deposits. The greenstone schists contain a certain proportion of iron compounds in their composition, and the bleaching action in proximity to the quartzites would seem to imply that these form the source of the iron ore, and possibly that of the silica with which these ores are invariably associated. The iron-bearing quartzites occur in the form of attenuated overlapping lenses along what are evidently sheer planes of remarkable persistence, which, by virtue of their lamination, have formed channels for the more or less free circulation of mineral-bearing solutions.

On either side of the hematite-bearing belt numerous quartz reefs outcrop, and several mining centres—Yarri, Edjudina, Linden, Eucalyptus, etc.,—have been opened up, and so far as may be judged by the official statistics, a considerable quantity of gold has been won, though it is doubtful if all the gold actually obtained has been officially reported. In view of the extent of what may be termed the Edjudina-Yundamindera mineral belt, and the number of reefs actually outcropping in addition to those actually worked, there seem to me to be sufficient ground to warrant rather more vigorous prospecting than would hitherto have apparently been the case.

By Authority: Wm. Alfred Watson, Government Printer, Perth.

ERRATA AND ADDENDA.

NOTE.—*The pagination is counted as one line.*

Page 6, line 46, *add*—

> Owing to exigencies of the public service, necessitating my presence in another portion of the State, it has not been found possible to devote any time to detailed petrographical descriptions of the various rocks embraced by this report. A great many sections have been cut with the view to microscopical examination, which it is hoped will be undertaken as opportunity offers.

Page 10, line 14, *for* "costeen" *read* "costean."

Page 10, line 15, *for* "costeen" *read* "costean."

Page 15, line 40, *for* "Bessemerprocess" *read* "Bessemer process."

Page 28, line 31, *for* "sheer" *read* "shear."

Page 58, line 30, *for* "sheer" *read* "shear."

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1904.

WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 12.

THE GEOLOGICAL FEATURES AND MINERAL RESOURCES OF MULLINE, ULARRING, MULWARRIE, AND DAVYHURST, NORTH COOLGARDIE GOLDFIELD,

BY

CHAS. G. GIBSON, B.E.,
ASSISTANT GEOLOGIST.

WITH TWO MAPS.

Issued under the authority of the Hon. H. Gregory, M.L.A.,
Minister for Mines.

PERTH:
BY AUTHORITY: WM. ALFRED WATSON, GOVERNMENT PRINTER.

1904.

PREFATORY NOTE.

THE examination of Mulline, Ularring, Mulwarrie, and Davyhurst was primarily undertaken with the object of showing the mutual relationship of the Auriferous Series at these different localities. The results of this investigation are shown on the maps, prepared by Mr. Gibson, which are correct so far as the scale of the field plans employed would permit. The ground embraced by the work covers an area of about 174 square miles, and includes all the important mining centres.

The staple formation of the district, apart from the extensive cover of the ubiquitous superficial deposits, is made up of a complex of hornblende rocks ("Greenstone"), which form the auriferous series, conforming in this respect to the other fields so far examined. The series form a belt of ten or more miles in width, and probably some 150 miles in length. There seem to be good grounds for believing that this forms part of the belt which includes Coolgardie, 90 miles to the south, and Mount Ida, 54 miles to the north; thus proving a known auriferous belt of 144 miles in length, along which it would not be unreasonable to anticipate the occurrence of other deposits quite as rich as any of those already opened up.

The hornblende rocks are intersected by biotite-granite, from which dykes attaining a thickness of 30 or 40 feet emanate. Some of these have been followed across country for several miles, and in one instance a dyke has been worked for its gold contents.

The quartz reefs, though with one or two exceptions small (and when worked below water level contain large quantities of sulphides), seem on the whole to be well defined, and give every promise of being permanent.

The report is accompanied by schedules of gold returns, compiled from the latest official statistics, which demonstrate that, from the area embraced by Mr. Gibson's work, there have been raised, up to the end of 1902, 73,625·33ozs. of gold from the crushing of 44,788·91 tons of quartz, thus giving an average of over one and a-half ounces of gold to the ton.

With the advent of systematic scientific mining, together with the erection of suitable machinery, there seems every reason to believe that the district will show a marked increase in its gold output in the future.

So far as the origin of the gold is concerned, it is quite clear that in the Ularring District the deposition of the gold took place after the intrusion of the granite, at whatever geological period that occurred.

The district is, as a whole, well-timbered, though not particularly well watered; this condition of affairs might be overcome by either surface conservation or well-sinking.

The report and explanatory maps, being submitted to the Hon. the Minister for Mines, were ordered to be printed for public information.

A. GIBB MAITLAND,
Government Geologist.

Geological Survey Office,
Beaufort Street, 20th January, 1904.

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MAPS.

I. Geological Sketch Map of Mulline, North Coolgardie Goldfield. Scale, 40 chains per inch.

II. Geological Sketch Map of Mulwarrie and Davyhurst, North Coolgardie Goldfield. Scale, 40 chains per inch.

The Geological Features and Mineral Resources

OF

MULLINE, ULARRING, MULWARRIE, & DAVYHURST.

Boundaries of the Field.—The North Coolgardie Goldfield was proclaimed on 29th May, 1895. It had its boundaries altered on 12th March, 1897, and at present embraces an area of 30,609 square miles, which, according to authorities, is bounded:—

> "By lines starting from the southernmost corner of the Murchison Goldfield, being the south-west corner of the East Murchison Goldfield, and situate about twelve miles east and five miles south from trig. station K.75 on Wyemando Hill, and extending south to the south-east corner of the Yalgoo Goldfield, which is a point due east from Mount Gibson, near Lake Moore, and due north of a spot ten miles west of a cairn on Yorkrakine Granite Rock; thence east-south-east to a point about fifty miles due west from a cairn marked N.B.1, near Wangine Soak; thence east to survey station N.B.1; thence about 87° twenty miles twenty-two chains to survey station R.3; thence east to the 125th meridian east longitude; thence north along that meridian to a point east of a tree marked B.82 at Brickey's Soak; thence west through the said tree to a spot about 76¼ miles west from it, and thirteen miles north and fifteen miles east from the summit of Mount Ida; thence north about thirty-one miles to the south boundary of the East Murchison Goldfield, and west to the starting point."

This field, which originally formed part of Coolgardie, and from which it was divided owing to the discovery of many rich reefs around Menzies, and the rapid increase of population, has, for purposes of administration, been subdivided into the Menzies, Ularring, Niagara, and Yerilla districts.

History of the Field.—Nothing official has been recorded of the history of the North Coolgardie Goldfield.

Previous Observations on the Geology of the Field.—Beyond a short report by Mr. Woodward * on the Mount Ida district, nothing official has been written about the geology of the field.

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* Annual Progress Report of the Geological Survey, p. 12, 1901. By Authority: Wm. Alfred Watson, Government Printer, Perth.

The Extent of the Map.—The area which has been mapped and depicted on the plan embraces an area of about 174 square miles, and includes the mining centres of Riverina, Mulline, Ularring. Mulwarrie, and Davyhurst. The map makes no pretensions to absolute accuracy, except in the near vicinity of the mining leases, the nature of the country, and the absence of any distinctive hills or landmarks rendering accurate work almost impossible at any distance from the lease pegs, that is, with the means—compass and plane table—and time at my disposal.

General Description of the Country.—The country generally consists of level plains covered with a considerable thickness of recent superficial deposits, through which rise low rough greenstone hills and ridges, and bare outcrops of intrusive granite. These greenstone ridges are especially numerous in the Riverina district, where they rise to a height of about a hundred feet, trending northwards beyond the limits of the map and then away slightly west of south past Mulline and Ularring to a point some four miles south-south-west of the latter place, where they die out below the alluvium of the plains, re-appearing again about a mile north of Mulwarrie and running south through this place and on towards Callion beyond the southern boundary of the map. Eastward from Mulwarrie towards Davyhurst the country is uniformly flat, the greenstones outcropping here and there, but being for the most part covered with superficial deposits varying in thickness from a few inches to many feet. The hills and ridges are often covered with a capping of considerable area of ironstone gravel.

Intruded into the greenstones in several places are large masses of granite. These occasionally outcrop as low bare hills, of which the Ularring Rocks are a typical example, but more often are found to be covered to a considerable depth with loose sandy soil resulting from their own weathering.

The greenstones are bounded on the west by a belt of intrusive granite, which rises as a low north and south ridge of hills some six or eight miles west of Mulline. Intermediate between these hills and the greenstone ridges of Mulline and Ularring is a considerable extent of sandy flats, which, from their general appearance, are probably overlying granite, and which are thickly covered with spinifex and stunted mulga.

Numerous dykes of acid eruptive rocks are found intersecting the greenstones in all directions, especially in the neighbourhood of Mulwarrie, where, however, their prevailing strike is north-west and south-east, and where they can be followed across country for some miles.

The belt of greenstones, which forms the auriferous series has a general north and south trend, and is at the least some eight or ten miles in width, and is probably the same belt in which the auriferous deposits of Coolgardie and Mt. Ida are situated.

Recent Superficial Deposits.—These are of two kinds: (*a.*) The loose incoherent material which is found covering the greater portion of the district, and (*b.*), the nodular ironstone gravels. Of these, the former is of very considerable extent, covering the flats and low-lying country to a depth of from a few inches to 50 or 60 feet; it is the result of the gradual weathering of the older granite and hornblende rocks, and where found overlying the former is much lighter in colour, looser, and more sandy, and is generally covered with spinifex and stunted mulga. The nodular ironstone gravels, or laterite deposits, usually occur as the cappings of hills and ridges, and are of much more limited extent. Deposits of this kind are found throughout the State, and have been thus described by Mr. Simpson* in Bulletin VI. of the Geological Survey:—

> "These, with the gravels resulting from their denudation, are the most widely distributed iron ores in the State, but are unfortunately the most erratic in quality, varying from a ferruginous bauxite or claystone to an almost pure limonite or turgite. The structure is sometimes massive and almost homogeneous, but it is more frequently pisolitic or nodular, in which cases the concretions are richer than the interstitial matter. Occasionally the ore is cellular and streaky in colour whilst still more rarely it appears brecciated, the angular fragments then consisting of almost pure hematite or limonite. They are invariably found as superficial deposits overlying granite, diorite, or amphibolite, or chlorite schists derived from them. They are most largely developed on the caps of the hills or ranges but in many cases follow down the sides of the hills parallel to the undulations of the bed rock, from which they are not separated by any hard and fast line. In depth they pass gradually into such highly ferruginous rocks as the diorites of the Darling Range, or the amphibolites and chlorite schists of the interior. At Kalgoorlie, cappings of very rich laterite occur on some of the hills underlaid by clays now poor in iron, from which the iron was originally derived, for it represents the result of decomposition *in situ* of highly ferruginous amphibolite. At Darlington and elsewhere they are found to overlie granite as well as diorite or other basic rocks, but never far from the latter. They can, in every case, probably be accounted for by the concentration of the ferric oxide resulting from the surface decomposition of rocks rich in iron."

Hornblende Rocks (Greenstones.)—These rocks, which comprise the auriferous series, and to which the general term "Greenstone" has been applied, consist principally of a very fine grained diorite, passing in places into a coarse-grained variety, as well as an indefinite somewhat foliated rock, which is probably only an altered form of the former, and are for the most part very decomposed and weathered to a depth of from 150 to 180 feet. In the neighbourhood of the Riverina leases these rocks outcrop as rough ridges, and are but very little decomposed: they are massive with no signs of foliation, and are of both the fine and coarse-grained varieties; between these there is no hard and fast boundary, and they are evidently merely different forms of the same rock. South from the Riverina, past Mulline and Ularring, they are all of one class, consisting of a fine-grained, massive diorite. At Mulwarrie and its vicinity they are again of the two varieties, the fine-grained predominating however. There are also one or two small areas in this locality over which the rocks are somewhat foliated, the foliation running parallel to, and being apparently due to the presence of, numerous granite and felsite dykes, which run through the greenstones here in a general north-west and south-east direction.

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*Geological Survey of W.A. Bulletin No. 6, page 36, 1902. By Authority: Wm. Alfred Watson, Government Printer.

At Davyhurst again they are entirely of the fine-grained variety, but are considerably more foliated here than in any other part of the district. At one spot, about three-quarters of a mile west of Davyhurst township, they have been altered for a width of about two chains, probably by pressure due to faulting, into highly inclined actinolite schists. This belt of schists runs on a bearing slightly west of north and east of south, and can be followed across country for some distance, gradually passing on either side into unaltered fine-grained diorite.

Sections of each of these varieties of diorite show them, when examined under the microscope, to consist essentially of pale-green hornblende and triclinic felspar, with magnetite in small grains scattered through the section, the hornblende and the felspar being present in about the ratio of 3 to 2; the only difference between the two rocks being in the size of their component crystals.

This belt of greenstones is at the least more than eight miles across, and is probably the same belt in which the auriferous deposits of Coolgardie and Mount Ida are situated.

The junction of the greenstones and the granite is for the most part hidden by the superficial deposits, but where it can be seen the greenstones are found to be highly foliated and contorted, the lines of foliation being parallel to and dipping away from the line of the granite; small patches of foliated greenstone are often found caught up in the granite.

Granite.—Bounding the greenstones on the western side, and intruded into them in several places within the district mapped, occurs massive granite. This is of a fairly coarse-grained biotite variety, hornblende being, as far as could be seen by microscopic examination, almost entirely absent. It outcrops only in isolated cases, usually as low bare hills, being for the most part covered with its denuded remains, principally sand. A section cut from a specimen taken from the Ularring Rocks at trigonometrical station N.B. 9, and seen under the microscope, shows it to consist of:—

(*a.*) **Quartz.—Abundant in large irregular lumps and grains, and containing numerous inclusions.**

(*b.*) Felspar.—Very abundant, occurring as large irregular grains and imperfectly formed crystals; it is principally of the monoclinic variety, though a little plagioclase is present as well as a fair amount of microcline.

(*c.*) Biotite: Present in brown tabular crystals, but not very abundant.

(*d.*) Hornblende: Present in small dark green crystals, but only in very small quantity.

The rock is somewhat decomposed.

Acid Eruptive Dykes.—Intersecting the greenstones in many places are eruptive dykes of acid rocks; these vary in size from a few inches to 30 and 40 feet, and run in all directions; the more general strike of them, however, being about north-west and south-east. They are especially numerous in the neighbourhood of Mulwarrie, where they can be traced through the greenstones on a general north-west and south-east bearing for several miles. They are closely allied to and are probably connected with the main intrusive masses of granite. Microscopic examination shows them passing through all gradations, from a very coarse granite to exceedingly fine-grained compact felsites and quartzites. These dykes are more recent than the quartz reefs of the district, and are found in several instances cutting right through the latter, and as a rule without having any effect on their strike, dip, or gold contents. In one instance—at the Thunderbolt G.M., Mulwarrie—one of these felsite dykes itself is being mined; this is partly due to the presence of small quartz stringers running through the rock, forming a class of stockwork, and also to the presence of a fairly large body of quartz running alongside the dyke. Only the quartz and the stockwork are being worked, the dyke rock itself, when free from quartz, carrying no, or at most only a trace of, gold.

REEFS AND LODES.

Lodes.—Only a few instances of auriferous lodes are met with in the district, and as such they occur in intimate connection with the quartz reefs, and are usually found associated with numerous quartz stringers and veins and occasionally with large bodies of quartz; in some cases it being difficult to say whether they should be classed as lode formations or as quartz reefs. In appearance they differ only from the country rock in that they are usually more highly foliated and much softer, and generally traversed by small quartz veins. They have no defined walls, their boundaries, both horizontally and vertically, being determined solely by the decrease in the assay value of the stone. Speaking of the lode formations of Western Australia,* Mr. Simpson, in Bulletin 6 of the Geological Survey, says:—"A 'lode formation' may be defined as a more or less vertical zone of rock, usually continuous with the surrounding rocks, and of similar origin, but distinct from it in carrying metallic ores disseminated through it in payable quantities, and, as a rule, characterised by strong foliation. Deposits of this nature are probably deep-seated; at Kalgoorlie, mining operations have already proved their persistence to 1500 feet below the surface. The typical lode formations probably owe their origin to a shearing action having crushed and foliated portion of the rock mass in a certain definite direction, producing a more or less well-defined band of rock through which, by virtue of the foliation, mineral bearing solutions or vapours can have free circulation. In consequence of this, mineral deposits are formed within the rock, usually, but not necessarily, extending over the whole of the foliated zone, but seldom beyond it, and having no definite boundaries, horizontally or vertically, other than those determined by the decrease of the assay value of the rock in any one direction to a point at which it ceases to pay the expenses of working."

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*Geological Survey, W.A., Bulletin 6, p. 22. By Authority: Wm. Alfred Watson, Government Printer, 1902.

Quartz Reefs.—These are found to vary considerably both in size and in the direction of their strike. The prevailing trend, however, is slightly west of north and east of south, though reefs with an almost due east and west strike are being profitably worked at the Mulline and Cooladdie mines, Mulline; the east and west reefs, however, are generally smaller and more irregular than the north and south ones. On the whole all the reefs in the district may be said, with one or two exceptions, to be small; they are, however, generally speaking, regular and very well defined, and give every promise of living to a considerable depth. Wherever worked below water level they have been found to be highly charged with sulphides; this also very often happens long before water level is reached, for example, the Lady Florence G.M., Mulline, and the Homeward Bound G.M., Mulwarrie. The gold both in the reefs and lodes is generally found to occur in chutes, the length of these chutes being, roughly speaking, from 150 to 300 feet.

Water.—The district as a whole is not particularly well watered. A good supply of fresh water can, however, usually be obtained during the winter months from the soaks at the Mulline, Cooladdie, and Ularring Rocks; this supply, however, depends on the rainfall, and generally gives out before the end of the summer. Fresh water has also been struck in two or three of the mines, viz., the Riverina mine at 160 feet, the Redleap mine, Ularring, at 135 feet, and the Mulwarrie mine, Mulwarrie, at about 160 feet. Water fit for stock purposes has been also met with in the Mulwarrie Main Reef mine, Mulwarrie, at a depth of about 120 feet. Generally speaking, however, the water supply of the district is salt, and, being unfit for domestic purposes, necessitates the use of extensive condensing plants. So far the supply in the mines is not known, as the majority of them have not carried their workings below water level, and no pumping is being done.

The following are the depths and the daily supplies from the Government wells in the district:—

Mulline State battery well, depth 130 feet, 13,000 gallons, carrying 1·13 per cent. of solids.

Mulwarrie State battery well, depth 160 feet, 4,000 gallons, carrying about 5 per cent. of solids.

Mulwarrie Government well, depth 158 feet, 4,080 gallons, carrying 2 per cent. of solids.

Davyhurst Government well, depth 137 feet, 1,200 gallons, carrying 2 per cent. of solids.

The water in each of these wells is salt, but at both State batteries it is suitable for, and is being used for, both milling and cyaniding purposes.

Timber.—The district as a whole is well timbered, such being especially the case in the vicinity of Mulwarrie and Davyhurst, where the low-lying flats are covered with a heavy growth of mulga, gimlet, and white gum.

THE MINES.

The following is a brief description of the principal mines working in the district at the time of my visit, June, 1903:—

Mulline District.

Riverina G.M.L., 123u.—There are a number of shafts on this property working on a fair-sized north and south quartz reef, which runs through the lease near its western boundary; the deepest of these is down about 160 feet. A main winding shaft has been sunk vertically to a depth of 200 feet about two chains to the east of the reef, and crosscuts put in to cut the reef at 100 and 200 feet. Levels have been driven along the reef at 80, 160, and 200 feet; that at 200 feet has been put in some 40 feet north and the same distance south from the main crosscut; no stoping has been done at this level; at 160 feet the drives extend 130 feet south and 50 feet north, whilst at 80 feet the total length of driving is about 300 feet, and for the whole of this length the reef has been stoped out to the surface. A short intermediate level has been put in at 120 feet, and a small amount of stoping done.

The reef consists of white quartz with varying thicknesses of schistose formation between it and the walls; this formation, as a rule, only carries a very small quantity of gold. The stone varies in size from one to three feet, the quartz being found at one time on the hanging-wall and at another on the foot-wall; the walls are clean and very sharply defined and run absolutely vertically, the distance between them averaging about four feet. The chute of gold at present being worked dips to the south at a steep angle. The country is soft down to about 160 feet, where it becomes very hard and settled; at this point sulphides begin to come in, and are fairly abundant at water level.

Fresh water was struck at about 165 feet.

Two other lines of reef run through this property; one is a short north-east and south-west reef, which outcrops near the centre of the lease. This, as far as tested, has proved to be entirely destitute of gold. The other is a north and south reef, which runs into the lease from the south near its western boundary. The only work done on this reef on this property consists of a shaft sunk to a depth of about 30 feet. The reef is about two feet wide, and is expected to average about 15dwts. The main line of reef has been proved through the entire length of the lease, and also for a considerable distance into the adjoining property on the north, where it has been worked to a depth of about 130 feet. Near the southern boundary of the Riverina it is cut off by an east and west fault, and thrown about 60 feet to the eastward. From this point southward its course is not so regular, it gradually turning away easterly as it runs through the adjoining lease (the Riverina South).

This property has crushed, up to the end of 1902, 5954·00 tons for 4,068·59ozs., giving an average of ·68ozs. per ton, the gold being worth £3 12s. 6d. per ounce.

Riverina South G.M.Ls. 324u, 600u.—The main line of reef at present being worked on this property is a continuation of the Riverina reef; as above stated, its course through this property is not so regular, the reef having a gradual trend away to the eastward. It has been worked to a vertical depth of about 130 feet on this property, and a considerable amount of stone taken out.

A second quartz reef is at present being prospected near the eastern boundary of the lease; this is a small reef running north and south, on which a shaft has been sunk to a depth of about 50 feet.

The stone crushed from these leases to the end of 1902 is 2,523·00 tons for 2,204·38ozs., being at the rate of ·87ozs. per ton.

Mulline G.M.L. 2u.—On this property a small quartz reef is being worked; the reef runs east and west, and dips at an angle of about 12° to the north; it varies considerably in size, ranging from a mere thread to as much as two or three feet; its average width is about 12 inches; the dip also varies a good deal.

A little to the east of the main line of shafts the reef is cut off by a fault which runs slightly to the east of north, and dips at a fairly steep angle to the westward; no extension of the reef has so far been found beyond this fault. Several north and south faults cross the reef farther west, it in each case being thrown downward for a few feet, and also slightly to the west.

The country is soft decomposed greenstone.

A large quartzite dyke runs north and south through the lease some 50 feet to the west of the main line of shafts cutting through the reef, without, however, displacing it at all. Several shafts have been sunk to cut the reef, the most northerly or main hauling shaft being down 90 feet vertically, thus being the deepest vertical shaft in the property. The reef itself has been followed on the underlay for a distance of slightly over 600 feet from the surface. At 300 feet, levels have been put in east and west for 40 feet each way, and stoping carried up to the surface for this length. Practically no driving or stoping has been done below this level.

A second small east and west reef outcrops close to the southern boundary of the lease; a good deal of work appears to have been done on it, but it is now abandoned.

The whole neighbourhood is full of small quartz reefs, all carrying gold, but not of sufficient size to pay for working.

Total stone crushed to the end of 1902 is 899·25 tons for 1,384·85ozs., being at the rate of 1·54ozs. per ton, the gold being worth £3 13s. 6d. per ounce.

COOLADDIE G.M.Ls. 333U, 408U.—The reef being worked on this lease is also an east and west one, with a very flat dip of 9° to the south. The lode consists of a quartz reef averaging about 12 inches in width, together with about two feet of schistose formation, which, as a rule, only carries a slight trace of gold, and is generally discarded. The quartz is found sometimes on the hanging-wall and sometimes on the foot-wall, and varies in size from 9 to 18 inches. The length of the chute of gold at present being worked is about 200 feet.

Several shafts have been sunk to cut the reef, the deepest being a little over 100 feet vertical. An underlay shaft has also been sunk on it for a distance of nearly 700 feet from the surface. At 600 feet, a level has been put in east for a distance of 50 feet, and the reef stoped out for this length up to 250 feet, and from this level to the surface for a distance of 150 feet east and 60 feet west.

The country is fine-grained greenstone, very soft and decomposed in the upper levels, but getting harder towards the bottom workings. No water has been met with, so far.

This mine has crushed, up to the end of 1902, 2,073·50 tons for 3,197·36ozs., giving an average of 1·54ozs. per ton, the gold being worth £3 12s. 6d. per ounce.

LADY FLORENCE G.M.L. 403U.—Two large quartz reefs run through this property in a north-west and south-east direction. On the most western of these three shafts have been sunk, two of which are now in use; of these, the deepest is down 120 feet, of which 80 are vertical, 20 underlay, and 20 vertical again, whilst the other is down 100 feet, 50 vertical and 50 underlay. Levels have been driven along the reef for about 100 feet at the 100 feet level and a little stoping done, while a good deal of driving and stoping has been done between this and the surface. The reef consists of white quartz averaging four feet in width, and has clean, sharp greenstone walls. The stone is very heavily mineralised from 100 feet down.

The second reef is about three chains farther east, and runs approximately parallel. Several shafts have been sunk on it, but only to a depth of about 40 feet, and practically no work has been done on it. The reef, where cut at 40 feet, is about 12 feet in width, and dips slightly to the east; the quartz is white, considerably broken, and ironstained.

This property has crushed, to the end of 1902, 631·25 tons of stone for a yield of 463·98ozs. of gold, being at the rate of ·73oz. per ton.

Lady Gladys G.M.Ls. 139u, 235u, 555u.—The original workings on this property were situated on a mass of highly decomposed greenstone immediately underlying a capping of ironstone gravel; a little quartz is disseminated throughout the mass in fine veins and stringers, and the whole over an area of about half an acre was highly auriferous. This was worked out down to a depth of about 30 feet when the gold suddenly gave out. At this point a small, very flat quartz reef was picked up. This reef was here about six inches in width, and dipped west at an angle of about 15 degrees. At the spot where first picked up it seemed to have been cut off to the north by an east and west fault as no continuation of it was found to the northward. The gold in the decomposed greenstone probably owed its existence to the presence of this reef, which was here exceptionally rich. The reef continues on its westerly dip of 15 degrees for about 40 feet, when the dip suddenly changes to about 35 degrees for 15 or 20 feet, and then back again to the original 15 degrees. In the lower workings the dip of the western reef gradually changes, and in the bottom level is about south-west instead of west. Just about the main line of shafts the reef takes another sudden change, and dips away steeply to the eastward. This eastern arm is somewhat smaller than the western, and as far as tested is practically free from gold. The size of the western arm varies from about 12 inches in the upper levels to about 2½ feet at the bottom levels. It has been worked out on the underlay to a vertical depth of about 150 feet. Several shafts have been sunk along the line of the cap of the reef, whose general trend is about north-west and south-east, and these have been connected by a main drive and the reef stoped out for a width of about 70 feet west of the line of shafts. The quartz is very heavily charged with pyrites below 110 feet, at which point the country begins to get very hard and compact.

The adjoining leases on the east are working small north and south quartz leaders. These dip to the east and are very rich in places.

Total stone crushed to end of 1902 is 5,915·00 tons for 14,347·71ozs., including 186·73ozs. dollied and specimens, giving an average of 2·42ozs. per ton, the gold being valued at £3 17s. 7d. per ounce.

Shamrock G.M.L. 1ʋ.—A small quartz reef runs through this lease, near its western boundary, on an almost due north and south bearing. Several shafts, all underlay, have been sunk on it, the deepest to a depth of 130 feet, and a good deal of work has been done. The reef is about 18 inches in width, and dips at an angle of about 60 degrees to the east. It has been stoped out from 130 feet to the surface for a distance of about 200 feet; from the surface down to 40 feet the gold contents were rather poor, but from this point down they averaged from 30 to 40dwts. The chute of gold is about 200 feet in length, and dips to the south. The country is fine-grained greenstone, and on the foot-wall at 130 feet is fairly hard and settled; on the hanging-wall it is much softer and more broken. No water has been met with, so far.

This mine has crushed, to the end of 1902, 1,009·25 tons for 1,623·08 ozs., giving an average of 1·61 oz. per ton.

Table showing Gold Returns from Leases in the Mulline District, other than those already mentioned, up to the end of 1902.

NAME OF LEASE.	No. of Lease.	Ore Milled. tons.	Gold Yield. ozs.	Average ozs. per ton.
Acrobat	327ʋ	55·67	85·50	1·53
Ajax	501ʋ	257·75	296·85	1·15
Albury	74ʋ	25·00	66·90	2·67
Anastasia	552ʋ (243ʋ)	20·00	9·90	·49
Argentina	450ʋ (357ʋ)	148·00	67·80	·46
Belle Mai	179ʋ	925·00	1143·57	1·23
Boer	446ʋ	11·00	5·00	·45
British Lion	162ʋ	68·30	78·75	1·15
Chamberlain	330ʋ	107·00	118·40	1·10
Cocas	433ʋ	34·50	46·50	1·34
Comet	601ʋ	72·00	63·80	·89
Cora	553ʋ	36·25	136·54	3·77
Chiltern	448ʋ	34·50	19·05	·55
Dawn	362ʋ	30·00	19·50	·65
Day Dream	206ʋ	10·00	2·10	·21
Day Dream South No. 2 Extended	314ʋ	81·00	94·75	1·17
Dismissal	688ʋ	22·00	13·64	·62
Don Juan	353ʋ	72·50	76·30	1·05
Duchess of York	603ʋ	134·00	79·07	·59
Dungan	340ʋ	156·50	101·40	·64
Exchange	542ʋ	7·00	11·75	1·67
Golden Lode	350ʋ	13·50	23·60	1·74
Gold Standard	435ʋ (315ʋ)	248·00	255·32	1·03
Great Expectation	483ʋ (385ʋ)	55·00	9·90	·18
Hornet's Nest	635ʋ	3·50	7·70	2·20
Karrakatta	575ʋ	12·00	89·50*	7·46
Lady Gladys Junction	670ʋ (290ʋ)	902·00	852·48	·94
Le Grand	534ʋ	7·00	6·60	·94
Marvellous West	328ʋ	158·00	159·85	1·01
Monarch G.M. Co.	451ʋ (95ʋ)	390·00	373·19	·96
Mikado	528ʋ	19·00	21·25	1·11
Mulline Commonwealth	704ʋ (206ʋ)	51·00	27·61	·54
Mulline Rose	595ʋ	31·50	18·08	·57

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* Includes 12·05ozs. dollied and specimens.

Table showing Gold Returns from Leases in the Mulline District, etc.—continued.

NAME OF LEASE.	No. of Lease.	Ore Milled. tons.	Gold Yield. ozs.	Average ozs. per ton.
Mulline Surprise	710U	17·50	22·23	1·27
Mystery	548U (437U)	137·00	141·35	1·03
New Find	409U	25·00	198·70	7·94
Nil Desperandum	434U (328)	646·75	889·76	1·37
Our Luck	311U	50·00	59·75	1·19
Queen Mary	583U	45·50	14·02	·31
Refuse	423U	58·00	50·05	·86
Reprieve Leases	422U, 462U	727·50	1718·25	2·36
Riverina Preseverance	545U	69·00	61·87	·89
Rose and Shamrock	357U	121·00	66·85	·55
Schnider	497U	18·00	14·15	·78
Three Gins	705 (390)	12·50	33·78	2·70
Try Again	367U	200·75	195·17	·97
Victoria	571U	62·00	97·14	1·56
Vera	385U	20·50	30·58	1·49
Waratah	661U	7·00	3·35	·48
Yankee Doodle	708U (345U)	29·00	13·65	·47
Young Australian	699U (332U)	170·00	373·17	2·19
Young Australian East	703U (332U)	7·50	3·04	·40
Sundry Claims	...	570·00	840·92	1·47

Ularring District.

REDLEAP G.M.Ls. 89U, 92U (London and Coolgardie Explorers, Limited).—There are five shafts on this property sunk on a quartz reef running north-west and south-east. These shafts are all underlay, and are from 130 to 165 feet in depth; the most southerly is the deepest, and has been sunk on the underlay 165 feet to water. From this shaft levels have been put in at 100 and 130 feet, but very little work has been done at this latter level. At the 100 feet a drive has been put in along the reef 150 feet south and 50 feet north, and the reef stoped out to the surface for a length of about 150 feet. This shaft is at present abandoned. The north shaft has been sunk 135 feet, at which point water was struck; at 100 feet a drive has been put in along the reef for a total distance of 300 feet, and a block 100 feet in length has been stoped out up to the surface. The reef averages some 10 inches in width, but is very irregular. Its dip, which also varies considerably, is to the east. A large quartzite dyke runs alongside the reef for some distance, and cuts across it occasionally without, however, displacing it at all. Fresh water was met with in this mine, it being one of the few mines in the district from which the water is drinkable.

The total stone crushed from this property to the end of 1902 is 1191·15 tons for 2,751·78ozs., being at the rate of 2·31ozs. per ton, and worth £3 14s. 6d. per ounce.

Table showing Gold Returns from Leases at Ularring up to end of 1902.

Name of Lease.	No. of Lease.	Ore Milled. tons.	Gold Yield. ozs.	Average ozs. per ton.
Block 45	692U	6·00	2·45	·41
Central Off Chance	351U	11·00	1·76	·16
Cuba	348U	4·00	14·55	3·63
Derby	666U	101·25	193·28	1·91
Lady Emma	383U	10·50	11·00	1·04
Lady Betty	376U	10·00	4·90	·49
Matchless	346U	8·00	3·05	·38
Off Chance	338U	1224·50	2481·13	2·03
Puzzle	370U	37·00	28·78	·77
Shamrock North	371U	38·00	28·27	·74
Trio	360U	88·75	102·15	1·15
Yale Lock	406U	30·00	6·75	·22
Sundry Claims	...	6·00	2·70	·45

Mulwarrie District.

Moonstone G.M.L. 522U.—A small quartz reef runs almost due north and south through this lease; it has been worked at the north end of the lease by means of a number of shafts and short drives to a depth of about 70 feet. At this depth it is lost. The gold is found to occur in a series of short chutes which dip steeply to the north. The reef is from six inches to one foot in width, and runs vertically; it is crossed by several small granite and quartzite dykes, which run in a general north-west and south-east direction. Some of the stone obtained from these workings averaged as high as 10ozs.; they are at present abandoned, and prospecting is being carried on near the southern boundary of the lease in the hope of picking up another rich chute. The country is fine-grained greenstone, and becomes hard and settled at about 70 feet. Granite and quartzite dykes are numerous in the neighbourhood, and are mostly small. They generally run in a north-westerly to north-north-westerly direction.

Total crushings to end of 1902, 135·00 tons for 758·73ozs., an average of 5·62ozs. per ton, and worth £3 17s. 10d. per ounce.

Mulwarrie G.M.L. 9U.—Several shafts have been sunk on this property on a line of reef running about north-west and south-east. At present the reef is being worked from one of these, which is down to a depth of 320 feet (90 feet vertical, and the remainder underlay); from this shaft the lode has been stoped out for a length of about 120 feet from the 300 feet level to the surface. A main underlay shaft is at present being sunk on the reef about five chains farther south.

The lode averages from two feet to three feet in width, and dips at an angle of about 45 degrees to the north-east. It consists of a quartz vein with a varying thickness of schistose formation accompanying it. The quartz vein varies in size from a few inches to as much as five feet or six feet in some places, in which case it practically fills the space between the walls, only a very little of the schistose formation being present. This, though it carries a little gold, is not as a rule sufficiently rich to pay for crushing. The quartz is found sometimes on the hanging-wall and sometimes on the footwall. The hanging-wall is very even and well defined, while the footwall is not so regular, pinches in the lode being due to rises in this wall. The country is fine-grained greenstone, very soft and decomposed in the upper levels, but becoming harder and more compact from about 90 feet. Numerous granite and quartzite dykes run across the lode, principally in a north and south direction. These are mostly small, ranging from a few inches to several feet in thickness. As a rule they do not throw the lode at all, but it is generally found to be poorer in close proximity to them. Water was struck at about 310 feet (measured on the underlay). It is slightly brackish, but drinkable.

Total crushings to end of 1902, 1,963·49 tons for 5,870·25ozs., being at the rate of 2·99ozs. per ton, and worth £3 11s. 8d. per ounce.

NORTH MULWARRIE G.M.L. 395U.—This property adjoins the Mulwarrie on the north, and the same line of lode has been worked on it to a depth of about 230 feet, measured on the underlay. Four underlay shafts have been sunk on the lode, the most southerly of which is only down about 70 feet, while the north or main shaft is down about 220 feet. About 50 feet of driving has been done from this south shaft, but it is not yet connected with the other workings. From the northern shaft about 400 feet of driving has been done at the lower levels, principally to the south, along the line of the lode. For the first 80 feet south from this shaft the lode consists of a talcose schist formation entirely free from quartz, and carrying only a slight trace of gold. South from this point the quartz begins to make and continues to the southern boundary of the property, averaging about two feet in width and dipping at an angle of about 45° to the east, and being similar in every way to the lode in the Mulwarrie lease. So far, no make of stone has been discovered to the north of the main shaft. As in the Mulwarrie, the lode is crossed by several granite dykes, which run between north-north-west and north-north-east, and vary in size from one to 10 feet.

Total stone crushed to end of 1902 is 1,168·00 tons for 1,977·35ozs., an average of 1·69ozs. per ton, and worth £3 17s. 10d. per ounce.

KILLALOE G.M.Ls. 401U, 506U.—A small north-west and south-east reef runs through about the centre of this property, and has been worked to a vertical depth of about 120 feet by means of several underlay shafts, sunk on the reef, the deepest of which is about 160 feet, measured on the underlay. From this level the reef has been stoped out to the surface for a length of about 220 feet. It varies in size from almost nothing to about 15 inches, and dips to the east at an angle of about 45°. Associated with the quartz reef is from two to three feet of schistose formation, which usually carries a little gold, but not sufficient to pay for crushing. In the upper levels the quartz jumps from one wall to the other, but in the lower levels it keeps to the hanging wall, but is smaller and not so well defined as in the upper workings. The country is greenstone, soft and decomposed in the upper workings, but becoming very hard at the bottom levels.

Total crushings to end of 1902, 359·50 tons for 580·15ozs., an average of 1·61ozs. per ton, the gold being valued at £4 per ounce.

THUNDERBOLT G.M.L.—The owners of this property are working on a large felsite dyke which runs slightly west of north and east of south. On this dyke a shaft has been sunk vertically for about 45 feet, and levels driven north and south along the dyke for about 30 feet. A winze has also been sunk to a further depth of 15 feet. The dyke dips sharply to the eastward, and is from 20 to 30 feet wide. It carries a small amount of gold for its full width, as well as a considerable quantity of pyrites.

An irregular bunchy quartz vein runs along the hanging wall side of the dyke, and innumerable small quartz stringers run through it in all directions, forming a large stockwork. Some of the bunches of quartz are very rich, whilst others again carry only a trace of gold. Only these quartz bunches and the stockwork are being taken out at present. There have been no crushings to date, but the owners have about 80 tons of stone at grass, some samples of which, taken at random by myself and dollied, gave very good prospects.

About 12 feet north of the shaft the dyke is cut clean off by an east and west fault, and so far no attempts have been made to pick it up again in this direction.

ULARRING WESTRALIA G.M.L. 6U.—Two quartz reefs run through this property, both striking about north-west and dipping to the east at a steep angle. There are several shafts on each line of reef. The western reef is some four feet in width, but is very broken and irregular, especially in the upper levels. It has been worked out for a distance of 150 feet down to a depth of 75 feet. There are two short chutes of gold in this reef, one dipping north and the other south.

The eastern reef, which is the only one being worked at present, is smaller, being from 18 inches to two feet in width, but is much more regular, and has much better defined walls than the western, and gives every promise of continuing to live to a considerable depth. It can be traced on the surface for about ten chains through this property, and also for a considerable distance into the adjoining lease on the south. It has been worked out down to 65 feet for a length of about 120 feet, the chute of gold in this case dipping at a rather steep angle to the south. The country is fine-grained greenstone, and gets very hard and compact at about 60 feet. There is a considerable quantity of pyrites in the quartz at the lower levels, carrying good values in gold.

This reef, like most of the others in this district, is intersected by several small granite dykes; these, however, do not affect the reef in any way.

Total crushings from this property to the end of 1902 are 497·25 tons for 971·60ozs., being at the rate of 1·95ozs. per ton.

MULWARRIE MAIN REEF G.M.L. 494U.—The main line of reef runs about north-west and south-east through the middle of this property. Five shafts have been sunk on this, two near the south end of the lease and three near the centre; of these latter the most northern is down 75 feet, the intermediate one 60 feet, while the third or main shaft is down 100 feet, 60 feet of which are vertical and 40 underlay. A winze has also been sunk a further distance of 20 feet from the bottom of this shaft. The lode has been worked out for 100 feet in length from the 70 feet level to the surface. A good deal of driving has also been done along the line of the lode at 100 feet, but no stoping. The lode, which dips to the eastward at a fairly steep angle, is from two to three feet wide, and consists principally of quartz, together with a little schistose formation on each side of the quartz. Occasionally the quartz pinches out to a few inches, its place being taken by the schistose formation, the walls still remaining the same distance apart. This formation is usually a good deal poorer in its gold contents than the quartz, but up to the present the greater part of it is being sent to the battery with the latter. The whole of the lode carries a considerable percentage of pyrites at the lower levels, a little galena being also present and being usually found only in the quartz. Small veins of calcite also run through both the lode and the country rock, which is a fine-grained greenstone, soft and decomposed to about 100 feet, but very hard and settled below this point. Water was struck at a depth of 115 feet (vertical) and is slightly salt.

A shaft has been sunk to a depth of about 50 feet on a small parallel quartz reef near the south-western corner of the lease, but no further work has been done upon it.

This property has crushed, to the end of 1902, 242·00 tons for 678·50ozs., being at the rate of 2·80ozs. per ton.

BUNINYONG G.M.L. 557U.—There are two parallel lines of lode running through this property in a north-west and southeasterly direction. The most western of these has been worked to a vertical depth of about 110 feet by means of several underlay shafts. This lode, which averages about two feet in width, and dips to the eastward at an angle of about 60°, consists of soft highly-decomposed chlorite schist, with which is associated a good deal of quartz, usually occurring in bunches, some of them several feet in width, and generally very rich. A good deal of work has been done upon this lode, but it is at present (May, 1903) abandoned in favour of a small parallel lode some three chains farther east, on which a shaft has been sunk to a depth of about 25 feet, and about 20 feet of driving done. This lode is from six to twelve inches in width, and parts of it are very rich; it appears, however, to be cutting out at about the bottom of the shaft.

Total stone crushed to end of 1902 is 148·75 tons for 307·35ozs., including 11·00ozs., dollied and specimens, being at the rate of 2·06ozs. per ton.

Toledda, G.M.L. 644u.—Near the north end of this lease two shafts have been sunk to cut a small quartz reef which runs slightly east of north and dips to the east at an angle of about 30°. The reef averages from eight to twelve inches in width, but is very irregular, some bunches of stone up to three feet in width being met with; these, however, are generally very short.

The reef is crossed by several north and south faults, which run practically vertically, and generally throw it from three to six feet. The country, which consists of fine-grained greenstone, is very soft and broken down to about 80 feet, at which point it begins to get more settled and harder. The reef has been stoped out from the 50 feet level to the surface for a length of about 100 feet. The main shaft has been sunk to a vertical depth of 85 feet, and about 50 feet of driving and a little stoping has been done at this level. A small amount of pyrites is present in the stone from these lower workings.

At the south end of the lease several shafts have been sunk on a quartz reef striking north-north-west and south-south-east, and dipping to the eastward. A good deal of work appears to have been done on this reef, but it is at present abandoned, and no particulars were available at the time of my visit.

Total crushings to end of 1902, 81·00 tons for 100ozs., giving an average of 1·23ozs. per ton, worth £3 8s. 9½d. per ounce.

Oakley G.M.L. 308u, 391u, 442u.—This property is situated about three and a half miles south-south-west from Mulwarrie townsite. A number of shafts have been sunk, and a considerable amount of work done on a small quartz reef striking about north-east and south-west, and dipping at an angle of about 45 degrees to the east. The reef is at present being worked only from the most northern of these shafts, the others being for the present abandoned. This shaft is down about 150 feet on the underlay. At the 125 feet level about 75 feet of driving has been done along the reef southerly, and the reef stoped out from this level to the surface for a length of about 50 feet; no driving has been done northerly. The reef is patchy, and varies in size from a few inches to two feet—where seen it was from 10 to 12 inches—the walls, however, are clean and well defined. The country consists of fairly coarse-grained greenstone, and is very soft and decomposed down to the bottom workings, but not at all broken.

This property has, up to the end of 1902, crushed 1548·00 tons for 3430·46ozs., being at the rate of 2·21ozs. per ton.

Table showing Gold Returns from Leases in the Mulwarrie District, other than those already mentioned, up to the end of 1902.

NAME OF LEASE.	No. of Lease.	Ore Milled. tons.	Gold Yield. ozs.	Average ozs. per ton.
Big Buck	363U	102·50	135·82*	1·32
Break o' Day	610U	57·00	13·00	·23
Cranbrook	581U (529U)	7·50	7·12	·95
Daimio No. 2	373U	24·00	63·93	2·66
Discovery	580U	136·00	63·05	·46
Dreyfus' Release	430U	32·20	27·25	·84
Dum Dum	452U	10·00	8·37	·83
Enterprise	561U	109·00	68·20	·62
Fairy Queen	377U	108·00	47·71	·44
Federal	449U	12·00	7·35	·61
Floral	402U (50U)	72·00	49·19	·68
Golden Star	550U (449U)	10·00	9·75	·97
Killaloe North	658U	15·00	15·00	1·00
Lady Emma	383U	10·50	11·00	1·04
Mona	400U (40U)	164·50	318·74	1·94
Mt. Egan's Big Gun	252U	2·00	6·70	3·35
Mulwarrie West No. 1	554U	11·00	4·10	·37
Mulwarrie Perseverance	474U	9·00	9·30	1·03
Pride of the Hills	627U	111·00	358·20	3·23
Pride of Wales	657U	14·00	6·00	·43
Q.E.D....	695U	8·00	12·60	1·57
Right Bower	419U	10·00	8·68	·86
Roseleaf	407U (366U)	74·50	128·86	1·72
South Mona	533U	41·00	122·35	2·98
Star	567U	19·50	25·65	1·31
Stella May	664U	9·00	5·45	·60
Stephenson's Big Gun	364U (252U)	74·00	72·32	·97
Sunnyside	607U	13·00	9·95	·76
Victorian	499U	33·00	12·70	·38
Welcome	520U (428U)	41·00	47·70	1·16
Sundry Claims	...	112·50	113·65	1·01

* Includes 3·82ozs. dollied and specimens.

Davyhurst District.

GOLDEN POLE G.M.Ls. 459U, 468U, 484U.—The main shaft on this property is down vertically to a depth of 300 feet, and levels have been put in north and south along the reef at 130, 200, and 300 feet. At the time of my visit the 300 feet level was full of water. At the 200 feet about 150 feet of driving has been done, principally south, and at the 130 feet about 400 feet, 250 feet south and 150 feet north. No stoping has been done to date. Two old underlay shafts are also down on the reef, the deepest being 160 feet. The reef, which is of white quartz, has a general trend slightly west of north and east of south, and is about two feet in width on the surface, gradually widening to about four feet at the lower levels; it dips steeply to the east near the surface, but in the bottom workings is practically vertical.

At about 100 feet south from the main shaft the reef takes a sudden turn almost due east for about 60 feet, and then southerly again on its original course for another 150 feet, when it is cut off by an east and west fault, dipping steeply to the north. So far, no attempts have been made to pick it up again beyond this point. A considerable quantity of pyrites is present in the stone at the lower levels, and a good deal of manganese is associated with the quartz on the walls of the reef, especially in the upper levels. Water was struck at about 280 feet, and is salt. The country rock is a fine-grained greenstone, very hard and compact in the lower levels, but soft and decomposed down to about 130 feet.

Stone crushed to the end of 1902, 1,004·00 tons for 2,599·85ozs., an average of 2·58ozs. per ton.

Homeward Bound G.M.L. 441u.—Several lines of reef run through this property in a north-north-west and south-south-east direction. These reefs are bunchy, and in places run up to six feet in width; their dip is vertical. Very little work has been done on any of them, the deepest shaft being only down about 50 feet. The lodes consist almost entirely of quartz, with several inches of hornblende schist on the walls; this schist usually carries very good gold. The stone is very heavily mineralised after about 30 feet from the surface. The country is very hard, compact greenstone, the zone of weathering only extending down about 30 feet.

Total crushings to the end of 1902, 151·00 tons for 102·15ozs.

Homeward G.M.L. 440u.—The main shaft on this lease is down 95 feet vertically. A crosscut has been put in westerly at this level for a distance of 40 feet, when the reef was cut. This reef has been driven on for from 15 to 20 feet northerly; it consists of a quartz vein some 18 inches in width, with several inches of schistose formation on the walls, and dips at an angle of about 75° to the west.

A second shaft has been sunk on a second line of reef farther east to a depth of 100 feet, and the reef stoped out for a length of 75 feet from the 100 feet to the 50 feet level. Above this level the stone is of too low grade to pay to take out.

This property has, up to the end of 1902, crushed 157·00 tons for 288·80ozs., an average of 1·84ozs. per ton.

Waihi G.M.L. 438u.—Three parallel lines of lode run through this lease in the prevailing north-west and south-east direction. On the most westerly of these a main shaft has been sunk to a vertical depth of 285 feet. Levels have been put in at 275, 200, 100 and 50 feet, and a good deal of stoping done at the two upper levels. This western ore body is some 100 feet in length, and is from two to four feet in width. It consists principally of quartz with varying thicknesses of schistose formation on the walls. At the lower levels very little quartz is present, and the formation carries only a very small amount of gold. In the upper levels the stone was very good, and some rich parcels were taken out.

Water was struck in the main shaft at 280 feet, and is salt. On a second lode, a couple of chains farther east, a shaft has been sunk to a depth of 100 feet, and a winze put down a further distance of 30 feet. A little driving has been done at the 100 and 50 feet levels, and a little stoping has also been done at the latter level. The lode, as opened up in the lower levels, consists of a rather irregular quartz reef some four feet in width, running vertically. Near the surface it is only about two feet. The country here gets very hard after about 50 feet. A small quartz reef, which appears to be a continuation of this one, has been worked at the extreme north end of the lease to a depth of 60 feet; not very much work has been done on it, however. A shaft has also been sunk to about 80 feet on a third line of reef still farther east, but no work beyond this has been done on it.

Total stone crushed up to the end of 1902 was 1,015·50 tons for 2,171·47ozs., including 5ozs. dollied and specimens, being at the rate of 2·13ozs. per ton.

EILEEN G.M.L. 458U.—The owners of this property are working on a large irregular lode, running about north-north-west and south-south-east, and dipping at about 60° to the west. The lode consists of a body of soft, highly decomposed chlorite schist, some six to eight feet in width, throughout which is disseminated a considerable quantity of quartz, both in the form of bunches and small veins running through the lode. It has no defined walls, and varies a good deal in size, being in one place as much as 20 feet in width. An underlay shaft has been sunk to a depth of 130 feet on the lode, which is here about six feet in width, and a drive put in along it at the 105 feet level for a distance of about 150 feet, and the lode stoped out for about 50 feet up from this level. The chute of gold at present being worked is about 150 feet in length, and dips to the north at a fairly flat angle. A main vertical shaft is being sunk a few chains to the north-west of the present workings. This is now (June, 1903) down about 200 feet. Salt water was struck in it at about 170 feet, at which point the country begins to get hard, being very soft and decomposed down to this point.

This property, up to the end of 1902, has crushed 1,867·00 tons for 2,435·12ozs., being at the rate of 1·30ozs. per ton, the gold being valued at £4 0s. 6d. per oz.

Oasis R.C. 92u.—The lode in this lease runs almost north and south, and dips to the westward at an angle of about 45°. It is very similar to that in the Eileen, consisting of a belt of highly decomposed schist averaging some four feet in width. It is very irregular, being as much as 10 feet in width in some places, and has no defined walls. A good deal of quartz is associated with it, occurring in bunches and small veins throughout the lode. The chute of gold being worked at present dips at a flat angle to the north. The lode is at present being worked from a shaft sunk to a depth of 65 feet near the south end of the lease. Two sets of levels have been put in from this shaft, one at 30 feet for a distance of 50 feet north, and one at 65 feet for 100 feet. Very little stoping has been done from either of these levels. There are also several other shafts farther north on the lode, the deepest of which is down vertically 165 feet. These are at present abandoned, but a good deal of work appears to have been done from them. Water was struck at 165 feet, and is salt. The country, as far as opened up, is very soft decomposed greenstone. Several other small shows are also working on this same line of lode farther to the south.

Great Ophir, G.M.L. 613u.—This property is situated about a mile and a-half to the north-east of Davyhurst township. There are four shafts on it, the deepest being about 90 feet. Of these shafts, one is vertical and two are partly vertical and partly underlay, while the fourth is a new shaft somewhat to the west of the others, which the owners intend sinking to a depth of 200 feet in order to try and obtain a supply of water. The country, as far as tested, is very soft, and consists of highly decomposed greenstone. There are several parallel lines of lode running across the lease in a general west-south-west and east-north-east direction. These vary in size from a few inches to about four feet, and consist of bands of highly foliated greenstone—probably old faults or joint planes—much decomposed, and carrying a considerable amount of oxide of iron, and throughout which a fair quantity of quartz is disseminated. The gold is found, for the most part, as very thin scales on the faces of the cleavage planes of the schists, and is extremely light and difficult to save on the battery plates. The main line of lode at present being worked averages about four feet in width, and dips at a flat angle to the north. Only a small amount of driving and stoping has been done on it. In the main vertical shaft a large body of brecciated quartz was met with at about 80 feet. At the time of my visit it was impossible, owing to no work having been done upon it, to say what the size of it was, or in what direction it was running; it may, however, be the continuation of a small north and south quartz reef which outcrops on the south end of the property, and on which a little work has been done to a depth of about 20 feet. This reef is here about 12 inches in width, and runs on a bearing of 340°; its dip is vertical, the stone is bluish quartz, and shows coarse gold freely.

Crushings to end of 1902, 99·00 tons for 72·30ozs., being at the rate of ·73oz. per ton.

Table showing Gold Returns from Leases in the Davyhurst District, other than those already mentioned, up to the end of 1902.

Name of Lease.	No. of Lease.	Ore Milled. tons.	Gold Yield. ozs.	Average ozs. per ton.
Champion	485U	36·00	17·30	·48
Forget-me-not	460U	176·00	440·24	2·50
Glengarry	465U	14·00	14·65	1·05
Golden Lode	691U	87·00	83·90	·96
Hanover	564U	47·00	40·40	·86
Hypatia	563U	50·00	23·20	·46
Jubilee	680U (620U)	39·00	33·00	·84
Lady Kate	697U (455U)	23·00	32·05	1·39
Macedon	659U	24·00	16·35	·68
Melrose	686U (439U)	35·00	95·35	2·72
Metalline	604U	54·00	39·50	·73
Three Hills	572U	40·00	2·20	·05
Waihi Consols	496U	73·00	168·30	2·30
Waihi North Extended	479U	11·00	44·75	4·06
Warne's United	491U	3·30ozs. dollied and specimens		
Sundry Claims	...	305·05	263·07*	·86

* Includes 1·40ozs. dollied and specimens.

SUMMARY.

In conclusion, it will be seen from the following table that the average gold yield from the district per ton of ore treated is an exceptionally high one, and also, as the ore value diagram shows, the total gold production for the whole Ularring district has been steadily increasing every year. There is no reason why, with systematic mining, together with the erection of suitable machinery, this increase should not be multiplied many times during the next few years.

Synoptical Table showing total Gold Yield from the District comprised within the boundaries of the map, up to the end of 1902.

—	Ore Milled. tons.	Gold Yield. ozs.	Average ozs. per ton.
Mulline	26,198·22	36,439·88	1·38
Ularring	2,766·15	5,632·55	2·04
Mulwarrie	7,501·69	16,464·08	2·18
Davyhurst	5,307·55	8,986·25	1·69
District generally—			
Being sundry parcels treated at Mulline and Mulwarrie State Batteries	47·00	2,027·90	...
Returns from voided leases	2,968·30	4,074·67	1·37
Total	**44,788·91**	**73,625·33**	**1·64**

CHAS. G. GIBSON,
Assistant Geologist.

APPENDIX I.

List of Specimens obtained from the Ularring District.

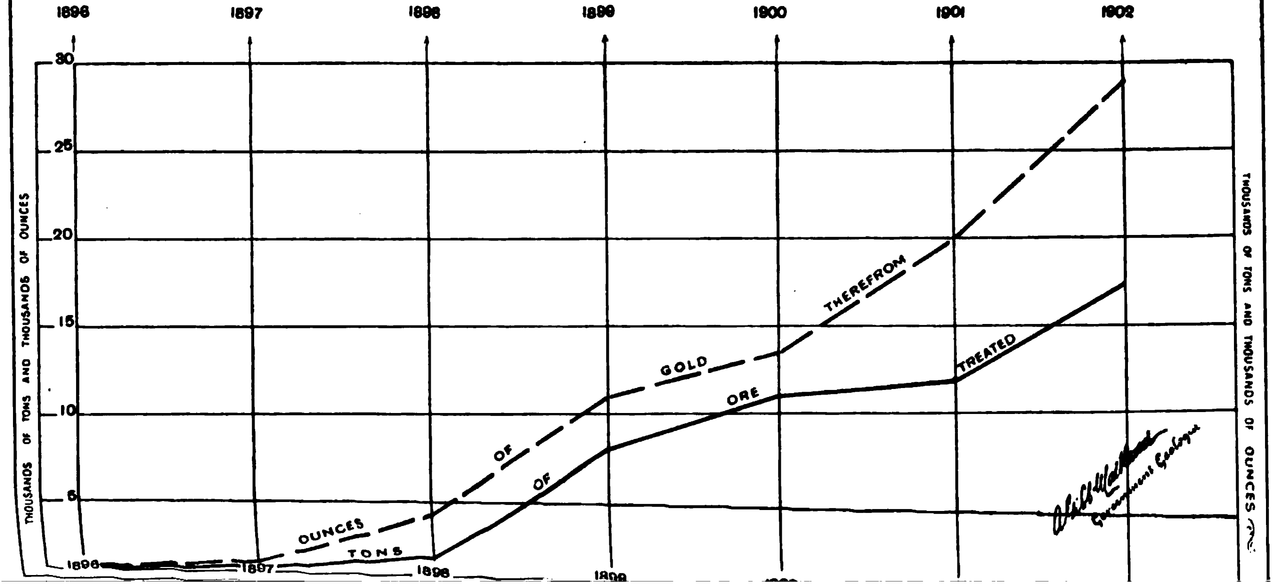
gistered o. of ecimen.	Registered No. of Microscope Section.	Name of Specimen.	Locality.
5008	337	Felsite (dyke rock)	20 chains west of G.M.L. 3632, Ularring
5009	...	Felsite (dyke rock)	2 chains south from above
5010	338	Diorite	G.M.L. 3632, Ularring
5011	339	Diorite	30 chains S.S.E. of G.M.L. 358, Ularring
5012	340	Granite (dyke rock)	G.M.L. 311, Ularring
5013	...	Laterite	G.M.L. 309, Ularring
5014	341	Biotite granite ...	Ularring Rocks, Ularring
5015	342	Felsite (dyke rock)	Thunderbolt G.M., Mulwarrie
5016	...	Granite (dyke rock)	G.M.L. 506, Mulwarrie
5017	...	Gold in schist ...	Great Ophir G.M., Davyhurst
5018	...	Copper Ore ...	G.M.L. 4550, Ularring

APPENDIX II

ULARRING DISTRICT

ORE VALUE DIAGRAM

Shewing Nº of Tons of Ore treated and Nº of Ounces of Gold obtained therefrom for each year since 1896



Government Geologist

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Niagara ...

North Coolgardie G.F. ...

North Mulwarrie G.M.L. 395U ...

Oakley G.M.Ls. 308U, 391U, 442U ...

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WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 13.

GEOLOGY AND AURIFEROUS DEPOSITS

OF

LEONORA,

Mount Margaret Goldfield,

BY

C. F. V. JACKSON,
ASSISTANT GOVERNMENT GEOLOGIST.

*Issued under the authority of the Hon. H. Gregory, M.L.A.,
Minister for Mines.*

WITH MAP AND SHEET OF SECTIONS.

PERTH:
BY AUTHORITY: WM. ALFRED WATSON, GOVERNMENT PRINTER.
1904.

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PREFATORY NOTE.

THIS report on the Geology and Auriferous Deposits of Leonora is one of a series designed to treat of the different important mining centres of the State. No previous detailed report has been issued on the district, although reference has been made to it by Sir John Forrest in 1869, and Mr. S. Göczel in 1894. The present report is the first which contains a geological map and sections of Leonora. The field work, upon which Mr. Jackson's work is based, was commenced on the 7th of July, and concluded on the 10th of October. The area embraced by the work extending over about 70 square miles.

The rocks of the district comprise a complex of crystalline schists which form the continuation of that group which is so largely developed in the other portions of the Eastern Goldfields, and are no doubt of the same geological age, viz., Archæan. Detailed mapping, however, has been rendered difficult by the cover of superficial deposits which occupy such an extensive area, and effectually conceals important geological boundaries often in critical localities.

According to Mr. Jackson's observations, it appears that the crystalline schists comprise both basic and acidic rocks. The basic rocks, which comprise the main auriferous series, form a belt of about an average width of one mile, and a proved length of 10 miles. This belt, however, extends much further to the North and South than the area embraced by Mr. Jackson's work. Some of the basic rocks (greenstones) have been converted into schists which are largely developed along the outer margin of the main belt, whilst the centre portion is occupied by more or less massive rocks. There seems good reason to believe that the foliated and schistose rocks are merely portions of one and the same mass which have suffered more or less dynamical metamorphism, possibly modified by chemical action.

All the important ore deposits are confined to the greenstones and their derivatives, which have yielded fully 95 per cent. of the total output, and on that account are worthy of careful investigation.

The greenstones have been invaded by granitic rocks, which latter occupy by far the most extensive area of country examined. The acidic rocks are both massive and foliated; it has, however, not been found possible to, in all cases, separate the different varieties. It is, however, quite possible that more detailed examination than was deemed expedient would result in the recognition of two distinct series of granitic rocks, (*a*) an older, traversed by zones of secondary shearing, possibly associated with auriferous quartz reefs, and (*b*) a much newer and comparatively unmodified granite, which may be represented by the felsite dykes, which traverse the greenstone schists in the north-west corner of the area in the vicinity of the Leonora Gold Blocks.

The exigencies of field work prevented detailed petrographical work being carried out, but a series of rocks have been sliced, and as opportunity offers they will be microscopically examined.

The granites and greenstones are covered in places with lateritic deposits, a high and a low level laterite having been recognised, but it has not been found possible to separate both on the map, hence the two varieties have been distinguished by the same colour and symbol.

The ore deposits have been conveniently divided into four classes, particulars of which are fully set forth in the text.

The report is accompanied by schedules of gold returns prepared from the latest official statistics; these demonstrate that from the area embraced by Mr. Jackson's work there have been raised, up to the end of 1903, 331,824·92ozs. of gold, the result of the treatment of 420,792·50 tons of quartz, being at an average rate of 0·78ozs. per ton.

The report, map, and sections, having been submitted to the Hon. the Minister for Mines, were ordered to be printed for public information.

The index to names, places, mines, reefs, etc., occurring in the report, has been prepared by Mr. H. W. B. Talbot, the Field Assistant.

A. GIBB MAITLAND,
Government Geologist.

Geological Survey Office,
Perth, 4th February, 1904.

GEOLOGY AND AURIFEROUS DEPOSITS

OF

LEONORA

(Mt. Margaret Goldfield).

INTRODUCTION.

History of the Mount Margaret Goldfield.

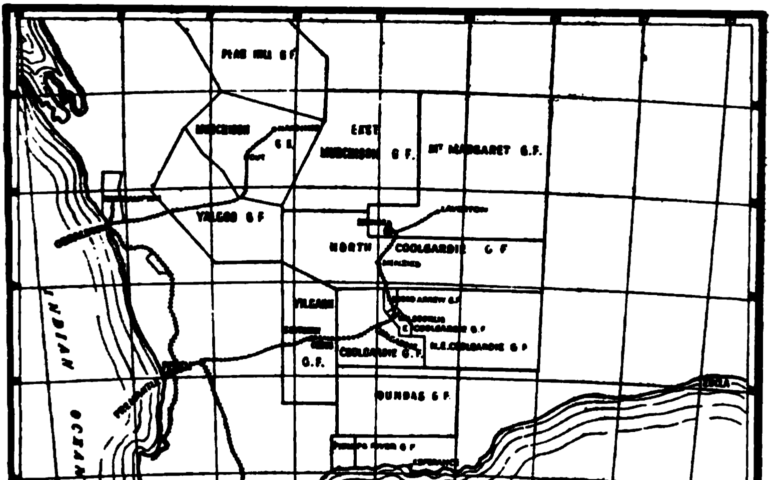

Fig. 1.--Locality Map.

Production.

The following is a tabulated statement of the gold production of the total ore of the Mt. Margaret Goldfield, as defined by the authorities:—

	oz.	£
Previous to 1897	4,992·10	18,471*
1897	22,592·09	83,591
1898	49,717·77	183,956
1899	79,923·72	295,718
1900	145,688·75	539,048
1901	190,032·15	703,119
1902	211,308·77	781,842
1903	212,490·60	786,215
Total	916,745·95	£3,391,960

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* Value of gold, assumed, £3·70 per oz.

The route followed by Sir John Forrest, when commanding the West Australian Expedition in search of the remains of Dr. Leichardt and party, crossed the now existing boundary of the Mt. Margaret Goldfield, near the South-Western corner, and the history of the country comprising its area commences, geographically speaking, with following extract from the explorer's diary of the expedition:—

> 24th June, 1869. . . . . . "From the summit of a remarkable peak, which I named Mt. Flora, I obtained a round of bearings, and saw a high range bearing about north 106° east mag., apparently about 16 miles distant, towards which we travelled till after dark.
>
> "25th. . . . . . Saddled at dawn and proceeded to the range, about five miles distant, and on reaching it I ascended the highest peak, and named it Mt. Margaret."

From that date but little further knowledge was gained of the country, or, indeed, little attention paid to it, for more than 20 years; and it was not until 1894 that the Mt. Margaret, or Lake Carey, country began to be regarded as a prosperous and rising district.

In a report on the Interior Gold Region of Western Australia, (*) published in 1894, Mr. S. Göczel, describing the country passed over on an expedition from the "Ninety Mile" to Lake Carey, mentions the Lake Raeside depression, which he crossed some miles to the south of Mt. Leonora, and which forms the drainage area of the southern portion of the field. He noted the position of the large outcrops of granitic rocks, which rise as a range of bare hills to a height of 200 feet above the surrounding country, and form, with a width of about five miles, the divide of the watershed of Lakes Raeside and Carey. Mr. Göczel further stated that a long stretch of country, situated at the junction of this gneissic granite on the west, and greenstone on the east, had already been proved auriferous, and he mentioned the "Red Castle" line of reef and the "Goose's Puzzle," and stated that, though rich finds had not been made up to that time, a number of reefs offered chances for profitable mining enterprise.

Farther east, on the range of which Mt. Margaret forms the highest point, he referred to alluvial gold deposits at Red Flag, Hawk's Nest, and other surface workings, the Hawk's Nest being the richest.

At the end of 1895 the population of the whole of this large district amounted to 730, while there were 3,400 acres held under mineral lease, and two 10-stamp batteries situated at Mt. Margaret.

During 1896 numerous new finds were reported, viz., Mt. Margaret, Mt. Malcolm, Mt. Leonora, and Murrin Murrin, all then within the North Coolgardie Goldfield; and it was not until the 1st April, 1897, that Mt. Margaret was constituted an independent goldfield, formed by separating portions of the North Coolgardie and East Murchison Goldfield, and having an area of 42,154 square miles.

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* Report on the Mines Department. Perth: By Authority, 1895.

Apparently, at the time, the centre of Mt. Malcolm gave promise of being the most important, and the Warden's Office for the transaction of the departmental business of the new field was opened there on the 10th May, 1897, the area being divided into the two districts of Mt. Margaret, 17,150 square miles on the eastern side, and Mt. Malcolm, 2,516 square miles on the western side.

In the same year the Westralia Mt. Morgans Gold Mines was registered as a local company, and on the 3rd March following the Sons of Gwalia, Limited, which gave a great impetus to the mining centres of Leonora and Morgans, these two mines being now the chief producers of the field. The Under Secretary for Mines, in his Annual Report for 1898, refers to the developments of the field during that period as being little short of phenomenal.

During 1899 a public battery started operations at Leonora, and further copper deposits were found and furnaces erected at Anaconda, in the vicinity of Murrin, where similar ores had been previously located. The yield of gold for the year amounted to 5 per cent. of the total production of the State. Developments were almost equally satisfactory in the following year, 1900, especially in the vicinity of Mount Margaret, and to the east and south-east of Laverton; and 4,539 tons of copper ore were treated at Anaconda. The gold yield rose from 5 per cent. to 9·6 per cent. of the State's total production, a proportion which increased to 10·3 in 1901, when the copper output from Murrin, valued at £40,738, amounted to rather more than half the State's total. The Warden of the field reported, at the end of 1901, that progress was marked more by attention to legitimate development of prospecting shows and mining at a depth than by the opening up of new country; remarks which apply also to the following year, when, however, the yield of copper showed a falling off, and the output was only valued at £6,852.

The gold production, nevertheless, maintained a satisfactory increase, and in April, 1902, a slight alteration was made in the administration of the field, by the creation of the new district of Morgans; the centres being now Malcolm, Morgans, and Laverton, the relative importance of which, as producers, is shown by the following comparative statement:—

1902.

District.	Population.	Production.
		oz.
Malcolm (including Leonora) ...	2,170	88,842·92
Morgans	1,114	59,091·55
Laverton	2,741	63,374·30

It appears, therefore, that since 1896 the record of the field has been one of continuous prosperity. A number of townships have grown up round the more important mines, and while the population of the field has increased from 730 to 6,025, the annual gold production in the same period has risen in value from £83,591 in 1897, to £781,842 in 1902.

It is not inappropriate to add that, speaking generally of the country passed over on his expedition in 1869, Sir John Forrest remarked: "As for minerals, I am not sufficiently conversant with the science to offer an opinion, except that *I should think it worth while sending geologists to examine it thoroughly.*

LEONORA DISTRICT.

HISTORY.

The following table shows the total gold production of the Leonora District:—

PRODUCTION.

	Ozs.	£
Previous to 1897	112·10 ...	415*
1897	9,056·91 ...	33,511
1898	19,475·37 ...	72,059
†1899	27,673·87 ...	102,393
‡1900	60,084·61 ...	222,813
1901	72,008·18 ...	266,430
§1902	68,804·58 ...	254,577
1903	74,609·30 ...	276,054
Total	**331,824·92** ...	**£1,227,752**

The township of Leonora is the present terminus of the Eastern Goldfields Railway, situated 323 miles to the east and 225 miles to the north of Perth.

The Leonora district forms portion of and occupies the south-eastern corner of the Mt. Margaret Goldfield, and its early history therefore also begins with the West Australian Exploring Expedition in 1869; not merely in a general sense, however, but, as is worthy of note, the country was traversed and examined in some detail. Quoting the paragraph from Sir John Forrest's memoirs especially referring to the locality:—

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* Value of gold, assumed, £3·70 per oz. † Ten stamps working at Sons of Gwalia. ‡ Sixty stamps working at Sons of Gwalia. § Sons of Gwalia output diminished. Mining costs decreased, profits increased.

> 20th June, 1869. . . . . . "From a bare granite hill about one mile from camp, I saw a high hill bearing north 81° 30′ east mag. about 25 miles distant, which I named Mt. Leonora; and another bearing north 67° east mag. about 25 miles distant, which I named Mt. George. Intend proceeding to Mt. Leonora to-morrow."
>
> 21st June. . . . . . "Steering towards Mt. Leonora, over some tolerably grassy country, we reached it at sundown, and not finding any water, camped without it, with very good feed; in south latitude 28° 53′ by meridian altitude of Lyræ (Vega) and Aquilæ (Altair), and in longitude about 121° 20′ east."

Thus is recorded the earliest history of the landmark from which the district derives its name.

In tracing its mineral history, it seems probable from what has already been said with regard to the Mt. Margaret goldfield generally, that the deposits mentioned by Mr. Göczel in 1894 include all those which were first known within its boundaries, and it is unlikely that there was then any mining in the district; though alluvial gold appears to have been discovered by fossickers not long afterwards.

It is generally agreed that the first discovery of an auriferous formation which led to more extensive search, and ultimately brought to light the valuable deposits now being worked, was made in 1896, by two prospectors—Sullivan and Weddeck—who, like most pioneers, arrived on camels, probably from Menzies or Niagara, the then nearest centres.

They discovered gold showing in a quartz outcrop about one and a-half miles north-north-west of the present township. Their lease, No. 4048, now the site of the public crushing battery, and known as the Johannesburg, was applied for on the 11th March, 1896, and surveyed on the 18th November of the same year. It has been forfeited and held again at different dates and under different numbers, *i.e.*, 238T, 152C; but, except that a good deal of rich gold was obtained from a large boulder forming part of the outcrop, there is but little authentic information concerning it. After the rich surface stone was worked, however, and a shaft put down, the ore proved too low grade or the vein too small to be payable. Occasionally fossickers are said to have obtained small parcels, the returns of which are no doubt included in the statistics under the head of "Sundry Claims," with the exception of a single crushing in 1902 of eight tons, which yielded 5ozs. of gold.

The two original prospectors were followed closely by others, and the next find of importance was made by McPhie and party, who discovered a reef two miles farther north, and pegged out Lease No. 195C, known as the "Great Wonder," now the "Leonora

Gold Blocks." The application for this lease was made on the 3rd June, 1896, while that for Lease No. 4263, containing the outcrop of the Sons of Gwalia lode, appears in the official register dated the 2nd June, 1896, though which of the two takes precedence as regards the discovery of the deposit is not recorded therein.

A great number of leases were quickly taken up surrounding those held by the lucky prospectors, and, as shown by departmental records, the progress of the district as a mining centre has been extremely rapid: a result, however, in great part due to the richness of the Sons of Gwalia lode, and intimately connected with the development of that property on a large scale after its purchase from the prospectors by Mr. G. W. Hall in 1896 for the sum of £5,000.

From 77 per cent. of the total in 1897, the production of this mine had risen at the end of 1902 to 93 per cent.; and the total output of the field for the same years amounted to 9,057·17ozs. in 1897, and 68,804·58ozs. in 1902. The increment added by the public battery, which started operations in 1897, and has crushed to date 10,960·5 tons for a yield of 10,153·82ozs., amounts in value to £38,583·18.

The accompanying geological map comprises an area of 70 square miles, hereinafter referred to as "the district."

It is bounded by an east and west line at Mount George, 4½ miles to the north of Leonora, and by a similar parallel at Lake Raeside, 5 miles to the south. On the east and west by meridian lines 4 miles and 3½ miles from the township respectively.

PHYSIOGRAPHY.

Approaching Leonora from the south, the general appearance is that of a long ridge of more or less pointed hills, extending with a north-westerly axis to Mount George; and in a southerly direction beyond Mount Leonora to Lake Raeside. The altitude of Mount Leonora and Mount George, which form the most prominent features, being 250 feet and 225 feet respectively above the surrounding plains.

This ridge, running diagonally from north-west to south-east, forms a natural division of the district into two parts, which it has been found convenient to refer to in the following pages as the eastern and western side of the area.

On the west are wide flats extending with an imperceptible slope to the eastern side of the Lake Raeside saltmarsh, which stretches in a north-westerly and south-easterly direction for at least 100 miles, and of which the deepest parts are occupied by salt-water pools, and then dried up beds.

The country to the east, though largely occupied by flats, is rather more broken.

The district forms portion of the eastern watershed of Lake Raeside, the divide between this and the Lake Carey drainage area being approximately 12 miles to the east, while in a westerly direction, at a distance of from 4 to 5 miles, the country begins to fall towards the Lake Barlee Basin.

Mr. Göczel, in 1894,* writing of the Interior Goldfields of Western Australia, refers to them in general terms as being situated in a region having very slight, if any, drainage towards the sea: "Absorption, evaporation, and percolation to the saline flats and salt lakes balancing the rainfall." The altitude of Leonora, but slightly different from the other goldfields, is about 1,220 feet above sea level; and the annual rainfall of the district, so far as records have been kept, has varied from a minimum of three inches in 1897 to a maximum of 12·16 inches in 1900, or an average for the six years of 7·42 inches.

Relatively speaking, the district is well provided with water, that first met with in the mine and well shafts being freely made use of. This supply is generally obtained at about 60 feet, but at a shallower depth in the alluvium to the west, where several areas have been selected for cultivation. The water obtained from the upper levels, though containing a fair proportion of lime and magnesia salts, is used for boilers; and, suffice it to say, with certainly not more than the average inconvenience attendant on the use of such water on the goldfields, where the necessary boiler-cleaning resulting on the presence of a considerable proportion of solids has frequently to be undertaken.

Tanks are chiefly relied on for drinking water, but the township is provided with a gravitation supply, the water being obtained from a well and raised to an elevated reservoir by a powerful windmill pump.

GEOLOGY.

Broadly speaking, the district may be geologically defined as an area of crystalline schists; of which by far the greater portion is covered by recent superficial and alluvial deposits. These latter are in most cases derived from the accumulated detritus of the older rocks, while metamorphism has not in general been so great that the nature of the rocks themselves cannot be distinguished; and according to the acid or basic character of the original form, a geological division made conformable with the general scheme of rock classification.

In point of geological age, also, the rocks can generally be recognised as referable to, in fact, part of the same group so largely developed in the Eastern districts, and outcropping, as they do, at either one or another of the mining centres thus situated.

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* *Ad interim* Report on the Department of Mines, 1894, pp. 24, 25. Perth: By Authority, 1894.

Geologists, writing of the Goldfields,* have described them as being divisible into three sections—Granites, Gneisses, and Schists; and on this basis have assigned a more or less definite position to each, thus:—

"The first auriferous belt of hornblende, mica, or talc schists (about 20 miles in width) extends from the Southern Cross Goldfields in a south-easterly direction to the south coast, and in a north-westerly direction to and beyond Cue, in the Murchison Goldfield.

"The second auriferous belt, similarly composed, includes Coolgardie, Kalgoorlie, and extends with a parallel axis, and with a width not yet explored, from Norseman on the south, through the Pilbarra Goldfield, to Egina and Mallina on the north-west coast.

"The Leonora District, in fact the whole of the Mt. Margaret Goldfield, is included within the second auriferous belt; the country between the belts and to the west being occupied by the above-mentioned granites."

At the same time the granites, gneisses, and schistose derivatives were classed as Archæan rocks, and have been most frequently thus spoken of by other geological observers; while the diorite, diabase, pyroxenite, with the hornblende and chlorite schists, have been most generally referred to as "paleozoic greenstone."

Both granite and greenstones are represented at Leonora, and an examination of the small area, though not affording any new evidence as to the exact geological age of the formation, raises the question of the ages of the rocks within it, in so far as the relation is concerned, of the greenstones to the granites, to which discussion in this respect is practically limited, for though each division undoubtedly contains more than one primary form, further separation is impossible owing to so large a proportion of the area being completely hidden from view, as well as to the highly decomposed state of the schists where outcrops can be examined.

The crushed rock forming Mount Leonora, as well as the smaller areas to the north and south, is no doubt of intrusive origin and of later age than the greenstones, as also probably the remainder of the granite area represented; but further evidence in support of the latter general conclusion would be more satisfactory.

Superficial Accumulations.

The development of recent accumulations in the district is very extensive, as indeed has already been noted on almost all our Eastern Goldfields; but there are many important features with regard to these residual deposits and their distribution at Leonora, where in one form or another they cover all except the most elevated areas.

On the eastern side, occupied by the granitic schists, the surface is covered by the usual soil resulting from the decomposition

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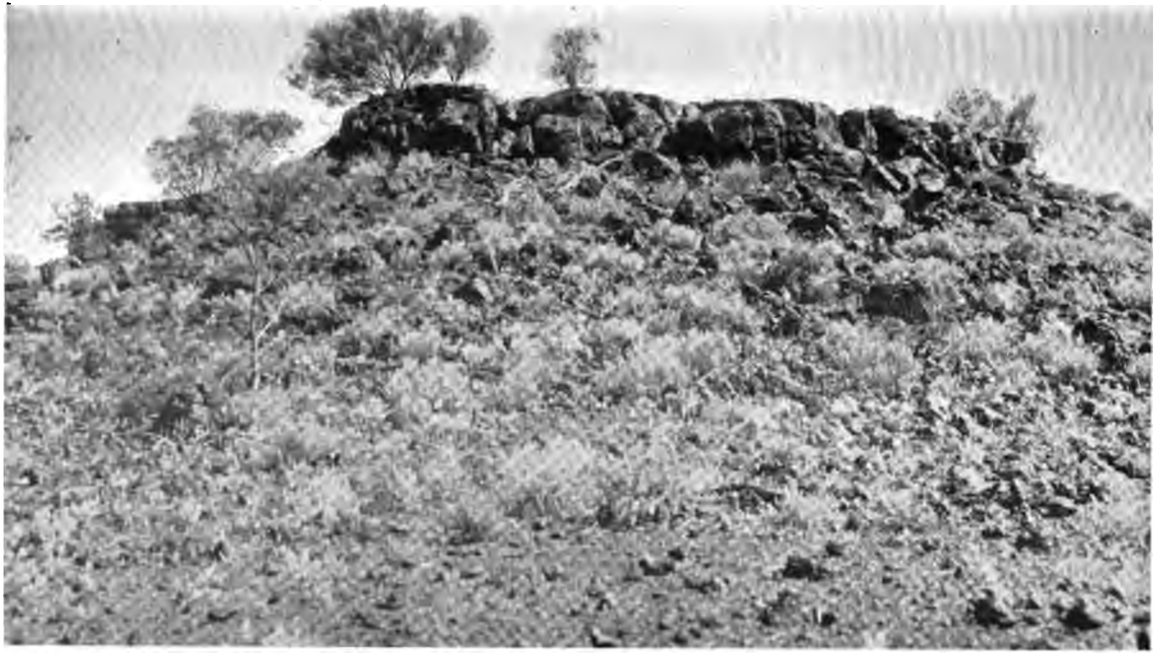
* Mining Handbook to the Colony of W.A. Harry P. Woodward, pp. 36, 37. Perth: By Authority, 1895.



High-Level Laterite, One Mile North-East of Mount George.

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of the schists *in situ*, which, in the depressions, has accumulated to a very considerable deposit forming wide sandy flats. The higher portions, however, from which the finer products of degradation have been removed, are more frequently covered by quantities of ironstone, consisting of fragments of highly ferruginous clay, representing those portions which have become hardened, and charged, no doubt by a concretionary process, with the iron of the original rock mass, now become to a great extent bleached and decomposed.

On the western side the superficial covering is probably in great part more of an alluvial character, no doubt of considerably greater thickness; and to it, even now, are being added the more or less sedimentary accumulations of Lake Raeside. The waters of this lake, in addition to the deposition of mechanically suspended silt, have left in places, chiefly as a result of evaporation, a siliceous residue of lime salts, particularly at the outer margins. In some cases the lime is sufficiently free from other substances to form, when burnt, a local supply for building purposes, but as a rule is too impure.

Apart from the influence which the existence of the salt pools or lake may have had upon its present form, practically the whole of the material filling the depression on the western side appears to have been derived from the disintegration, *in situ*, of a previously existing residuary deposit, *i.e.*, the ironstone gravel, which bears a comparable resemblance to the laterite of such wide distribution throughout India and Ceylon.

This formation, the remains of which are shown on the map, either in the high level or low level form, no doubt not only covered the greater part of this area, but extended through the gap in the dividing ridge known as the "Gorge" for a considerable distance beyond the limits of the map. These laterites are a typical formation of the Eastern Goldfields, and both types are represented in the Leonora district. The high level form, of a dark brown colour, is the more highly ferruginous; and is often of pisolitic appearance, or shows a brecciated structure at the base, due to the detrital rock fragments becoming re-cemented into the mass, which may be a compact impure ironstone.

The deposit now only occurs in the form of detached outliers, sometimes presenting a vertical cliff face from 15 feet to 20 feet in height (Plate I.); and where the original surface can be examined, the highest portions are found to be at an elevation of from 80 feet to 100 feet above the mean surface level. This corresponds with the observations in the Coolgardie Goldfield, where a sample was found to contain, as oxide, the equivalent of 25 per cent. of metallic iron, and one recently collected in the neighbourhood of Boogardie, as much as 51·67 per cent. and 11·46 silica.

The low level variety is of much greater extent, and between the areas occupied entirely by this formation and the more recent alluvium, it is often difficult to differentiate on a merely superficial examination. The deposit is more of the nature of a ferruginous clay, which, by the development of concretionary structures, has become nodular, particularly in the upper portions, the iron ultimately appearing on the surface in the form of fine red dust and hard brown ironstone pebbles.

The origin of these laterites, both here and also in India, appears to have been a subject of some speculation; but of the deposits at present under discussion, while the low level varieties have in great part a detrital origin derived from the high level form, there is no evidence suggesting that the latter have been formed otherwise than *in situ*.

Underlying the deposits above described, and between them and the original rock masses beneath, there is almost always a thin stratum of calcareous material, locally called "cement," a formation which follows the contour of the rock surface and varies from a few inches to a few feet in thickness, and, being intensely hard, its removal requires the use of explosives.

This occurrence, also, is by no means uncommon, nor, indeed, limited to Western Australia, as a description of an almost identical occurrence has recently been published in the Transactions of the American Institute of Mining Engineers, Vol. XXXI.,* an article which supplies a comparison for those of our own State.

The material consists of an earthy limestone or travertine, often containing a breccia of rock fragments, and, like the other superficial deposits already mentioned, has been formed *in situ*. The cementing substance chiefly composing it has been derived from the decomposition of the lime-bearing minerals of the underlying rocks, and the process and formation one of solution and redeposition.

Finally, with regard to the superficial deposits as a source of gold—the first type only, *i.e.*, that covering the granite schists on the east, can be said to have yielded alluvial gold in the sense of the term ordinarily understood in Western Australia.

The others have only served to hamper the operations of prospectors, and often, even when the proximity of an auriferous reef has been proved by the occurrence of gold in the surface boulders of quartz "floaters," its position has never been located. That such remarkable success has been met with can only be regarded as an argument in favour of further expectations.

THE GREENSTONES.

The group of rocks comprising both massive and schistose forms to which the term greenstone is now being generally applied, have by far the greatest economic importance of any in the district; and with the extension of mining operations, an accurate knowledge of their extent and relation to the other rocks becomes second only

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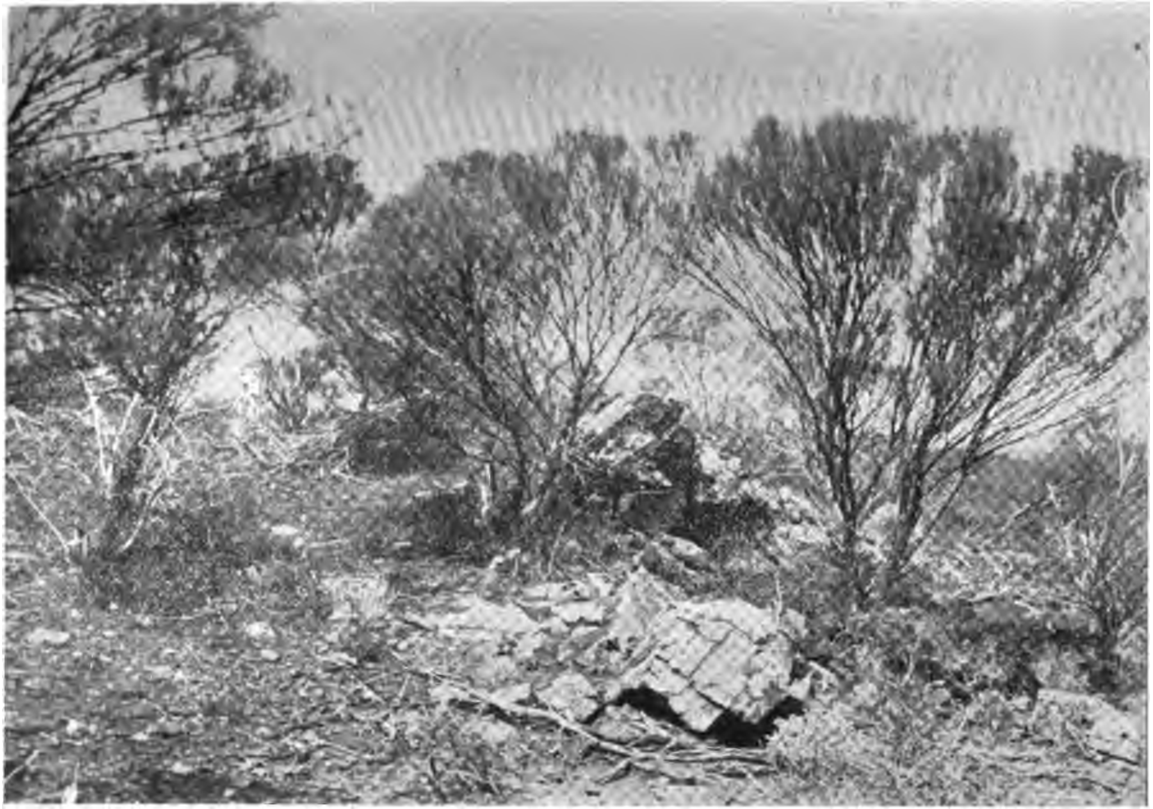
* The Caliche of S. Arizona, William P. Blake, Transac. Am. Inst. M.E., 1902, Vol. XXXI., pp. 220, 221.



Typical Outcrop of Banded-Quartz in Greenstone, One and a-half Miles South of Mount Leonora.

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in importance to a knowledge of the ore-bodies within them, which yield from 60,000oz. to 70,000oz. of gold annually, or 95 per cent. of the total output.

The formation occupies a diagonal strip of the map, and must be regarded as a single area of basic rock, which has been more or less crushed, foliated, or completely converted into schists, the latter structure being on the whole the most usual, and to such schistose zones the auriferous reefs are almost entirely confined.

An examination of the area enables those portions which are occupied by the completely schistose rock, "greenstone schists," to be distinguished from those occupied by the massive and foliated greenstone; and furthermore, to the recognition of more than one variety of basic or ultra-basic rock; but not only is any further separation impossible, but, for reasons already stated, no satisfactory evidence is available with regard to the geological relation of the several varieties.

The greenstone schists are most largely developed on the outer margins of the main belt, in juxtaposition to the granite rocks, and, while the middle portion is occupied more or less by massive rocks, form two fairly well defined strips extending the whole length of the map. Those on the western side contain nearly all the important ore-bodies, and are of nearly the same composition, and similar in their characteristics, to the schists derived from similar rocks, "chlorite schists," occurring elsewhere.

The greenstone on the eastern side of the belt is found in an even higher state of metamorphism; a considerable development of the remarkable banded and hematite-bearing quartz forming one of the most noticeable features of the district. Along the summit of the ridge extending from Mount George to Leonora, and thence to Lake Raeside, outcrops of this quartz are found in the form of bands, or lenses, from 10 to 50 chains in length, and from 1 foot to 100 feet in thickness; and projecting several feet above the surface in the form of parallel-sided bars. (Plate II.)

They follow the general dip and strike of the schists, which have been altered by leaching and other processes for a considerable distance on either side; and appear to be similar to those at Bardoc, and to the occurrences mentioned in several reports on other goldfields, where their position is ascribed to "an old fault or line of joints along which the greenstones have been highly foliated." In the Boogardie and Lennonville Districts * they are auriferous, or associated with the auriferous deposits.

Their ultimate form seems to be due to a lode-forming process in the zone of weakness above referred to, but except in one instance at Leonora—"The Savanah Lode"—gold has taken no part in their mineralisation.

Specimens can be taken from the same outcrop of white quartz, of a banded quartz, and of a dark blue or grey compact variety

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* Lennonville, Mt. Magnet, and Boogardie, Bulletin of the Geological Survey of W.A., No. 8, pp. 16, 17; C. G. Gibson. Perth: By Authority, 1903.

having in a hand-specimen the appearance of a felsite; under the microscope, however, slices from specimens [**5101, 5102, 5222**][*] appear wholly as minutely crystalline quartz, containing a little iron oxide; the different appearance being due to the arrangement of the latter in bands, or in the blue grey variety to a more minute quartz mosaic and a more even arrangement of the iron.

The massive and foliated greenstone occupies, roughly speaking, the centre of the greenstone belt, being much more prominent at the northern end than at the southern end of the field, and an examination of the outcrops for specimens, which might serve as a guide to the original nature of the rock, does not furnish satisfactory evidence, since in almost every instance the rock is too decomposed for microscopic examination.

The best preserved specimen [**5068**][*] consists of decomposed hornblende with plagioclase, and has been essentially a hornblende rock, while in sections of the others, which are all more or less crushed, the, ferro-magnesian mineral shows complete conversion into chlorite; and the rock slices under the microscope are similar in appearance to those cut from specimens of the greenstones occurring at Coolgardie and Kalgoorlie, which have already been described in detail.[†]

One specimen only need be referred to [**5098**], which is in a very fresh condition, the rock being a diabase consisting of ophitically-arranged plagioclase and augite. I think it probable, however, that this rock is of later age than the basic rocks elsewhere. The specimen was taken from an outcrop of large round boulders occurring in an area of greenstone near the junction of the telegraph lines to the north-east of Leonora, and the outcrop itself occurs on a flat, and is surrounded by superficial deposits; but the remainder of the area, of which an examination is possible, consists of a rock similar to that occurring elsewhere.

THE GRANITIC ROCKS.

The existence of natural boundaries, as well as the considerations already referred to with regard to the greenstones, renders it advisable to similarly separate the granitic rocks into subdivisions of massive or foliated and completely schistose, though rocks are found grading from one type to the other.

The massive and crushed rock in which the original granitic structure can be recognised lies on the west, forming as it were a buttress, against which has been thrust the more schistose country to the east. Mount Leonora, with an elevation of 250 feet, forms a striking example of an intermediate stage of crushing and alteration (Plate III.), the rock having assumed a laminated form due to the pressure and weathering into large, more or less, rectangular blocks. Other small areas occur to the north and south, and appear—the

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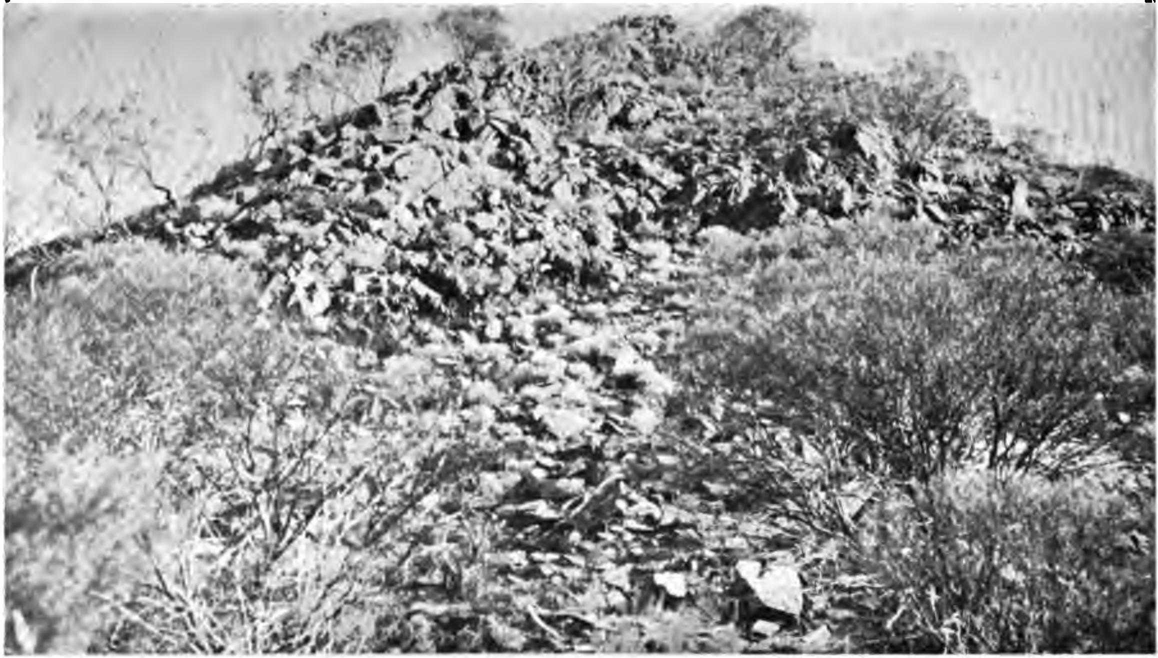
[*] The figures in heavy type [**5098**] throughout the report refer to the numbers of the specimens as entered in the Departmental Collection Register.

[†] Notes from the Departmental Laboratory, Geological Survey of W.A., Bulletin No. 6 pp. 62, 63. E. S. Simpson. Perth: By Authority, 1902.



Mount Leonora.—Outcrop of Crushed Granite; Dip, 55 degrees East.

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southernmost one, at least—to be completely included in the greenstone; but owing to the general leaching and alteration which has taken place, it is difficult to determine this point with certainty. The relation of these rocks to the greenstones has already been referred to on page 17.

Outcrops to the west are few, but the specimens collected show the predominating rock to be a gneissic granite; and the ferro-magnesian mineral, of which it appears to contain in some cases very little, was no doubt chiefly a dark mica.

The area to the east is distinguished from that to the west by the original form being in no case recognisable, and also by the extent to which the rocks have been effected by the agencies of decomposition. The result appears to be general, but there is a zone within the formation in which the process has continued to a very great depth. The original rock comprising this zone consisted, in its metamorphosed form, of a white fine-grained micaceous schist, and no doubt several varieties of granitic rocks occurred in the area; but the chief development has been that of a porphyry.

Sections Nos. 410, 411, of specimens [**5096**] and [**5097**] show under the microscope a minutely crystalline base with porphyritic quartz, No. 411 showing both porphyritic quartz and felspar—a quartz felspar porphyry. As far, however, as any evidence of relative geological age is concerned, these schists must be classed with the granites.

The following table gives a series of analyses made in the Survey Laboratory, under the direction of the Mineralogist and Assayer, of different varieties of the rocks referred to above:—

Table of Analyses of Rocks from Leonora District.

	G.S.M. **5,089**	G.S.M. **5,088**	G.S.M. **5,087**	G.S.M. **5,086**	G.S.M. **5,099**	G.S.M. **5,084**
SiO_2	47·70	50·98	42·17	53·09	76·22	76·71
CO_2	1·35	*Nil*	6·70	6·33	*Nil*	...
TiO_2	·52	·79	·55	·98	·86	·66
H_2O (Comb.)	6·62	1·08	2·97	·56	3·72	·24
Na_2O ...	·43	4·09	·45	8·09	·08	·07
K_2O	·38	·10	·26	·03	2·01	·11
MgO	22·49	4·70	24·71	3·36	·70	·06
CaO	·69	9·70	4·06	5·16	·66	·56
MnO	1·38	1·25	·55	...	Trace	...
FeO	7·33	8·35	8·18	1·73	...	...
Fe_2O_3 ...	1·60	·87	...	4·36	3·52	1·70
Al_2O_3 ...	9·99	17·09	9·29	16·03	12·55	20·08
Fe	...	·09	·13	·12	...	...
S	...	·10	·15	·14	...	...
H_2O (Hyg.)	·21	·05	·02	·05	·32	·21
	100·69	99·24	100·19	100·03	100·64	100·40
Sp. Gr. ...	2·08	2·95	2·85	2·73	2·47	2·81

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5089.—Schistose Greenstone (talcose). Tower Hill Lease No. 4387. Analyst, C. C. Williams.

5088.—Massive Greenstone. Tower Hill Lease No. 4387. Analyst, C. C. Williams.

5087.—Schistose Greenstone (chloritic). Tower Hill Lease No. 4390. Analyst, C. C. Williams.

5086.—Altered Greenstone. Half-a-mile East of Mount George. Analyst, C. C. Williams.

5099.—Massive Greenstone. Quarter of a mile north of Pride of Leonora mine. Analyst, C. C. Williams.

5084.—Crushed Granite. Near Trigonometrical Station, Leonora. Analyst, C. C. Williams.

Distribution and Character of the Ore Deposits.

With the system of mapping adopted, the ore deposits conveniently fall into four classes, according to the rocks in which they occur, but there is similarity throughout in a lenticular habit, and particularly in the tendency to follow the planes of foliation of the containing rocks. The term "bedded-vein," however, is in no way applicable.

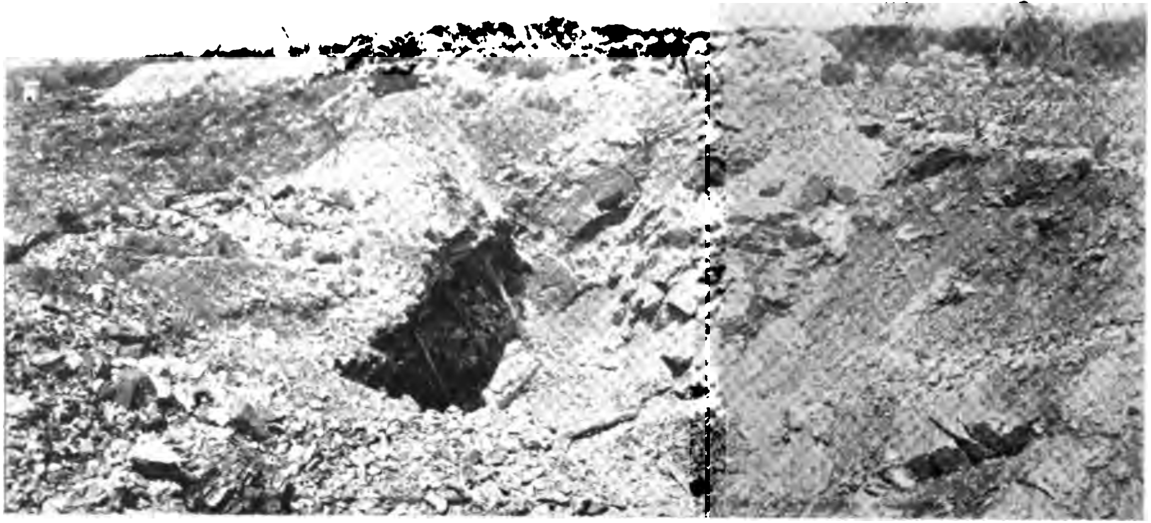
In the granitic rocks to the west there is only one representative in the "Trump" mine; while at the junction of these rocks with the greenstones, where the remarkable masses of quartz ("Quartz Blows") have been developed (Plate IV.), "the Forrest" and "Tower Hill" deposits alone are auriferous, the latter being of very great size.

The "Leonora Gold Blocks," "Sons of Gwalia," and "Gwalia South," with numerous other smaller occurrences, are examples of lodes and reefs wholly in the greenstone; while the "Lady Lena," "Ironstone" (Pride of Leonora), and "Sons of Australia" (Camel leases), are deposits in the granite schists.

There is a great variation in the thickness of the reefs, which in every case consist essentially of quartz: with, in the unoxidised portions, both iron and copper pyrites as associated minerals, the latter being regarded by prospectors as an indication of richer stone.

So far as their permanence at a depth is concerned, the workings, as a rule, have been entirely confined to the oxidised zone above water level; but from the information available, there is no reason to anticipate any failing in this respect, and in the Sons of Gwalia—a somewhat isolated occurrence in this district, however—development is being satisfactorily carried on at a depth of over 1,000 feet.

Of alluvial deposits, there are at most only two examples—that known as the "Specking Patch," at the north-eastern corner of the map, and a small area close to the Forrest mine. With regard to the former, where the workings extend over 30 acres, there is very little information obtainable, except that a good deal of alluvial gold was obtained, the largest piece being a nugget of 32ozs.



Outcropping Quartz Masses, Tower Hill.

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A great number of shafts were sunk through the superficial deposit just to the north of the Forrest mine, and it appears that several of these with the most easterly situation "bottomed" on a deposit precisely similar to the "pug" obtained in the so-called deep lead at Kanowna.*

This material was somewhat stratified in appearance, and in some places the joint surfaces showed films of gold, which I have no doubt was of secondary origin and derived from the northerly extension of the Forrest reef.

The Mines.

THE TRUMP MINE.

Lease.	Total Ore.	Total Gold.†	Average Grade.
	tons.	ozs.	ozs.
Nos. 263c, 482c	11,989·35	11,296·28	·94

† To end of 1908.

The leases are situated three miles north-west of Leonora, adjacent to the Lawlers Road on the western side, and the discovery of gold thereon, one of the first finds in the district, was made by Messrs. Collins, Armstrong, and Roach, in 1896. Some remarkably rich ore was obtained near the surface, the first parcels being crushed at Menzies, and a syndicate, comprising most of the original prospectors, at present own the property.

The deposit is interesting, both from its form and position, as it is the only payable one which has so far been found to the west of the Greenstone.

The strike of the outcropping portion of the vein is 66 degrees east of north, and the average dip about 12 degrees to the south; but farther from the surface, just above the water level, there is evidence of a steeper dip.

The prominent feature in the mine consists of a main quartz vein following the planes of foliation of the crushed granitic rock, which has been squeezed up, and a system of joints developed in the form of an anticline. Though the deposit generally follows one of the main partings of the rock, occasionally a portion has taken an upward course and finally followed a parallel parting above, so that the workings are very irregular, and it is difficult, without the aid of a plan, to trace its general course.

An outcrop is visible for a short distance to the east, but no trace of the reef could ever be found near the surface to the west of the main underlay shaft.

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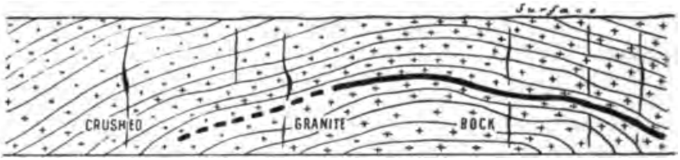
*Report on the so-called deep lead at Kanowna, Bulletin No. 3 of the Geological Survey of W.A., pp, 31, 32. T. Blatchford. Perth: By Authority. 1899.

The reason for this is evident on an examination of the workings, which also leads to the conclusion that the vein is in the form of a saddle, the axis of which has an east and west direction, and a slight dip to the west. At 250 feet, in the shaft, a long drive to the west, beginning with a slight upward incline, follows the vein, which at first had a southerly dip, but becoming quite flat and then assuming a northerly dip, there is a considerable fall to the end of the drive; which has thus passed over the cap of the saddle about 30 feet below the surface (Fig. 2).

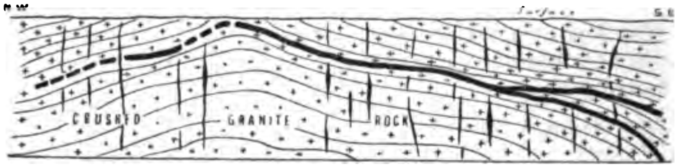
Fig. 2.



SECTION OF REEF ABOUT 2½ CHAINS S.W. OF MAIN SHAFT, TRUMP MINE.

The anticlinal tendency can be well seen on examining the rocks near the working shaft, and in an old shaft just to the north the reef appears to have been cut at a depth of 23 feet, lying in an almost horizontal position (Fig. 3).

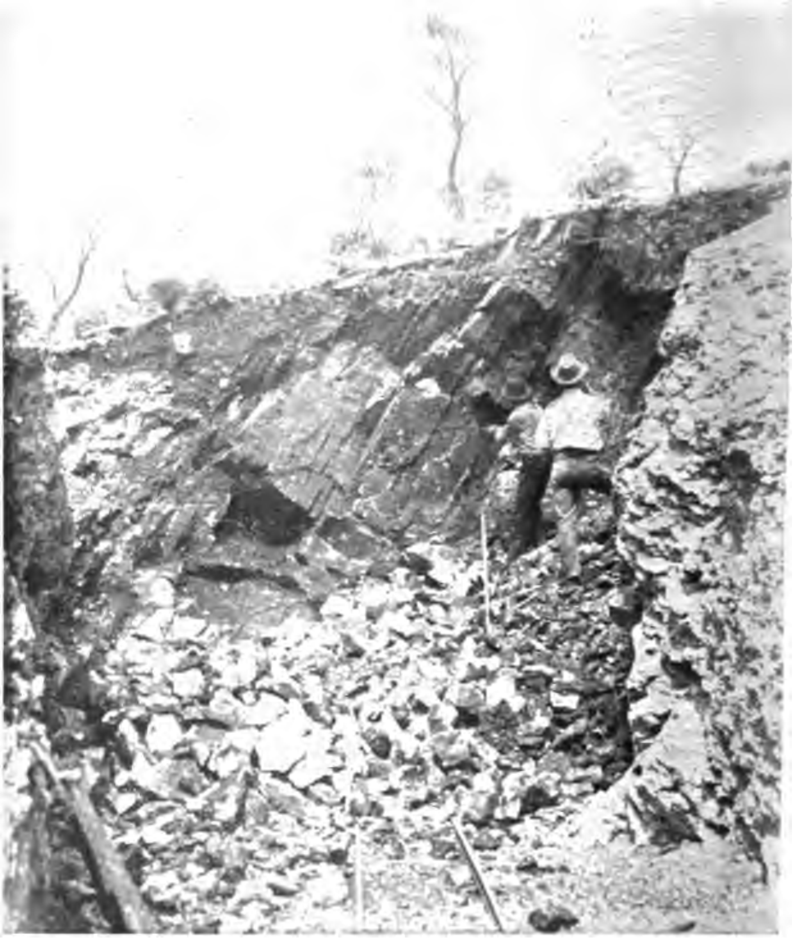
Fig. 3.



SECTION OF REEF AT MAIN SHAFT — TRUMP MINE

As well as these indications pointing to the existence of a northern leg, the formation of the deposit in a fissure, which owes its shape to the contortions which the gneissic rocks have undergone, suggests the possibility of an arrangement similar to that of the ore bodies in true saddle reefs. Prospecting operations, so far, have been chiefly directed towards testing the continuation to the south of the main vein already worked.

In this respect it may be mentioned that a water shaft about 200 feet south of the outcrop, after passing through the main vein at 14 feet, cut at 50 feet a small gold-bearing vein apparently dipping in the same direction and at a greater angle (65°). In addition to shafts, three diamond drill bores were put down at a



Open cut showing Hanging Wall of Lens and character of Quartz, Tower Hill.

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mean distance of about 15 chains to the south, but the particulars and results regarding them are only known to Messrs. Bewick, Moreing, & Co., by whom the work was undertaken.

Besides those following the foliation of the rock, there is a system of vertical or highly inclined veins, with a similar east and west strike; but apparently they do not carry payable gold, as they have in no case been removed.

Work has been carried on from an underlay shaft following the deposit for 400 feet, and at 240 feet the main vein is divided by a "horse" of less crushed granite; the lower arm having been followed and worked. Levels have been driven to the east at distances of 100 feet, 250 feet, and 300 feet, and to the west at 100 feet, 250 feet, and 270 feet, the bulk of the stoping being on the east. Development work, however, is now chiefly on the western side of the shaft, and has, up to the present, been entirely confined to the portion of the deposit above water level.

The main quartz vein, which is sometimes several feet in thickness, is flanked by smaller strings and veins, and the ore obtained contains a good deal of decomposed rock, which carries gold, probably in the filling of the joints. This associated rock has a noticeably bad effect on amalgamation, and an examination by the Departmental Mineralogist of a sample of the ore [5232], taken from the battery floor, showed it to contain, in addition to the ordinary constituents of a granite, the minerals pyromorphite (phosphate of lead) and mimetite (arsenate of lead); to which, as well as the large proportion of kaolin present, the interference with the process is due.

The Tower Hill.

Lease.	Total Ore.	Total Gold.*	Average Grade.
Nos. 218c, 219c	tons. 3,597	ozs. 1,192·05	ozs. 0·33

*To end of 1903.

The Leases, which were taken up early in 1897 by a prospector named Breen, are situated one and a-quarter miles south of Leonora, just to the west of the railway line, and are at present the property of the "Octagon Explorers, Ltd.," by whom nearly the whole of the prospecting work has been done.

There are several remarkable features about the deposit, which forms the best example of the occasionally auriferous nature of the quartz masses in the district.

A reference to the map will show the position of the principal quartz bodies. They are generally in the greenstone schists almost at their contact with the granite, but instances occur in which they are situated wholly in the latter rocks.

Throughout them all there seems to be a strong tendency to a lens-shaped plan, but there is not much information, to a greater depth than 500 feet, bearing on the question of their form in a vertical section.

All in the vicinity of Tower Hill are said to carry gold, but the operations of the syndicate have been chiefly confined to those at the north end, which are so closely associated as almost to form one continuous deposit, with an average strike in a north and south direction and a dip to the East of 45 degrees, similar to that of the schists.

Fig. 1, Plate VII., shows the position and the relation to the granite and greenstone of the deposit worked by the Tower Hill Company, which is by far the largest of any, and attains a width of 80 feet measured horizontally in the deepest crosscut.

The whole width, moreover, is composed of white quartz, which shows signs of crushing, and consists of a series of more or less solid portions running in distinct bands, with the space between filled with a more broken variety, there being a rough system of parting planes, along which it is broken down in blocks. (Plate V.)

There is scarcely, if any, associated rock, except at the outside near the hanging wall, where thin laminæ of schist are found in the quartz, some of the surfaces showing signs of slikensiding and thin scales of gold.

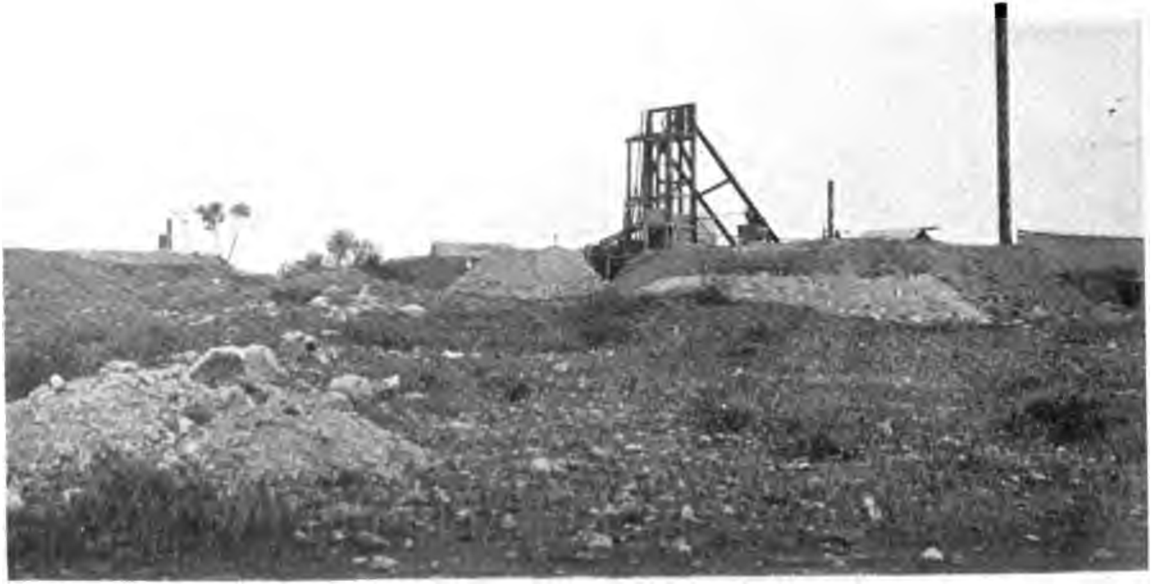
Some of the quartz lenses or " blows " contain areas of quartz and dolomite, the latter being ferriferous, which gives it a red colour; and there are also traces of copper carbonates, though not in the main deposit, where the whole of the gold is in an amalgamable form.

The first work of the prospectors was a large open cut, but subsequently shafts were put down to about 75 feet (water level), and the quartz explored by a system of drives. (Fig. 3, Plate VII.)

The quantity and value of the ore obtained have already been stated; but as regards the distribution of the gold in the deposit, the question is a difficult one to decide. Some information relative to its continuance has been obtained by a bore put down on the eastern side, which cut the hanging wall of the quartz at a depth of 366 feet 6 inches, and passed through the footwall at 501 feet 6 inches.

It appears that at this point the gold was not evenly distributed, but chiefly occupied more or less definite positions in the upper half and lower half of the quartz body. Further than this there is no evidence bearing on the question.

A reference to the map will indicate the numerous other quartz masses, the only similar deposit of importance being that known as the Forrest.



Leonora Main Reefs, showing Outcrop and Workings.

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THE FORREST.

(*Leonora Main Reefs.*)

Lease.	Total Ore.	Total Gold.*	Average Grade.
Nos. 210c, 253c	tons. 843	ozs. 1,297·58†	ozs. 1·46

* To end of 1903. † Includes 66·25 ounces from specimens.

The leases are situated two miles north-west of Leonora, and about a quarter of a mile west of the Lawlers road.

The reef was discovered by Messrs. Smith and others during 1896, and these original prospectors obtained most of the gold which the mine has yielded; the ore being crushed at the North Star battery, Mount Malcolm. They worked to a depth of about 60 feet, when the rather large supply of water put an end to their operations. The property then passed into the possession of a Perth Syndicate, finally the Leonora Main Reefs Company.

The deposit which has also a north and south course, but is almost vertical or with a slight tendency to a westerly dip, is of similar type to that of the Tower Hill, though rather more of the nature of a large quartz "reef."

It occurs in the same manner almost at the junction of the greenstones and granitic rocks; in fact, passes from one to the other, the reef at the south end being wholly in the granite; while in the vicinity of the workings in the greenstone, and in some places follows the junction.

In addition to a large reef more or less centrally situated, there are others of smaller size and what would seem to be detached masses; but satisfactory information with regard to the form and extent of the deposit cannot be obtained in the old workings, where the rocks are much broken and decomposed.

The present owners found it necessary to sink a new vertical shaft at the north end and just to the west of the outcrop, but owing to a temporary cessation of operations the water was allowed to accumulate, and the new workings were inaccessible. (Plate VI.)

From the bottom of this shaft, which was sunk to 155 feet, the reef was intersected by a crosscut 27 feet east, and has been explored by drives to a small extent at that level. When sinking was discontinued, the shaft was still in the greenstone schists.

In the early stages of the mine some remarkable specimens of gold in quartz were obtained, especially from Lease 210c, and these were secured by the West Australian Government for the Paris Exhibition.

Besides ordinary white quartz, the ore obtained has contained a considerable proportion of quartz associated with asbolite (an oxide of manganese containing several per cent. of cobalt), to which in some portions a prevailing black colour is due.

THE SONS OF GWALIA.

Lease.	Total Ore.	Total Gold.*	Average Grade.
	tons.	ozs.	ozs.
Nos. 190c, 207c, 353c ...	389,061	299,226·07	0·76

* To end of 1903.

The leases are situated 2¼ miles south of Leonora, and the original prospectors were Messrs. White, Glendenning, and Carlson. The official record contains an entry of lease 190c, which includes the outcrop, having been applied for on the 2nd June, 1896.

Development of the property has steadily proceeded since its purchase by Mr. G. W. Hall, in November of the same year, and the present ownership is registered under the title of the "Sons of Gwalia, Ltd."

The deposit is by far the most important of those situated in the Greenstone, and apart from its size has many distinctive features which separate it from others in the district; not so much as regards morphological characteristics as internal structure and mode of formation. It falls into the class which Mr. A. Gibb Maitland has described † as "impregnations in zones of rock," which, he says, "form the most interesting and possibly the most important source of the precious metal in Western Australia." Further, "that they are merely portions of a large mass of rock, which in consequence of dynamical agencies has permitted the free circulation and deposition from mineral solutions; and they are characterised by having no well-defined walls, the limit of the deposit being determined by the decrease in the assay value of the rock to a point at which it ceases to pay the expenses of working. They are generally known in this country as "lode formations," and will herein be referred to exclusively as "lodes" in contradistinction to the terms reef and vein used in other cases."

The Sons of Gwalia lode, the course of which is 16 degrees east of north and the mean easterly dip 45 degrees, occurs entirely in the greenstone schists; and is made up of numerous mineralised quartz veins of varying size and of distinctly lenticular shape.

These quartz veins have been developed over a zone of considerable width, the rock itself being also impregnated with minerals containing gold; but the actual lateral extent of the lode formation, except on the east where it is limited by a tabular mass of less crushed rock, cannot be accurately defined.

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† Mineral Wealth of W.A., Bulletin No. 4 of the Geological Survey of W.A., pp. 26, 27. A. Gibb Maitland. Perth: By Authority, 1900.

Mining, however, has been entirely confined within the formation to three "shoots" of payable ore; of such size and in such position as to be workable by a separate system of stopes; and in each of which the mineralised veins are so closely associated as to form more or less parallel ore bodies of compact quartz.

These shoots of ore are generally known as the "A" or "Main Lode," the "B," or "Eastern Lode," and the "Western Vein" a small parallel shoot which has appeared on the west of the "A" shoot, with some persistence, and has been mined in places as far as the No. 8 level. (Fig. 4, Plate VII.)

Each zone of highest value within the shoots, composed of an aggregate of the quartz veins, appears itself to have assumed somewhat of a lenticular form; having a core or lens of more highly mineralised quartzose material from one to two feet in thickness, and extending laterally from 20 feet to 60 feet—a "lens of ore."

A number of these lenses connected by a chain of values follow each other roughly in the same plane, and together with the impregnated formation containing them, giving a total stoping width which has varied from 6 feet to 30 feet, have made up the ore bodies of the mine.

Owing to their development, however, to a greater or less extent throughout the whole of the lode, and the fact, moreover, that a certain series of them only carry the payable values, the actual course of the shoot can only be followed by an elaborate and careful system of sampling.

The "B" or eastern shoot was of greatest importance in the upper levels; and as regards its horizontal extent, though its northern end may have been reached, both its limit of depth and southern extent are still uncertain. Until quite recently it had only been found on the one side of the shaft and explored to the Nos. 6 and 7 level. Compare figs. 1, 5, and 4, Plate VII.; but I believe the position has recently been located elsewhere.

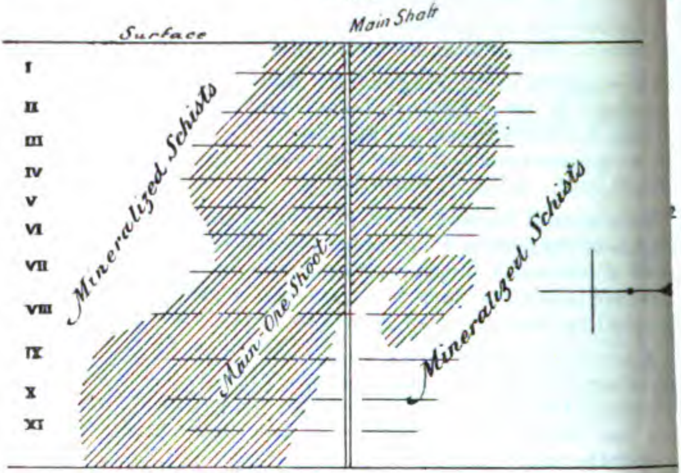
The westerly shoot has only been worked here and there in the upper levels, and would seem to be more of the nature of an offshoot making its appearance at a greater depth in the form of a "footwall vein" of the "A" shoot, which in such places attains a very great width.

The "A" or main shoot forms the most prominent feature of the mine, and is that on which attention is now being chiefly centred. In the upper levels it was worked on both sides of the shaft, and is now being worked on the southern side at the deepest level in the mine, No. 12.

The extent of the workings on this ore body has brought to light several characteristics which may also be appropriate to the others, particularly the southerly progression of values.

As a greater depth was reached the shoot was found to ha decided trend to the south, and the northern end, advancing a rate of about 60 feet per "level," passed to the south of the at about the No. 6 level, a habit which has been most consis (Fig. 4.)

Fig. 4.



PLAN SHEWING SOUTHERLY TREND OF MAIN ORE SHOOT, SONS OF GWALIA.

In the annual report of the directors of the company for 19 the ore reserves in this shoot are given at 133,417 tons, and in t "B" shoot 9,071 tons, a total of 142,488; which, in June, 19 had been increased to 188,623 tons, of average grade.

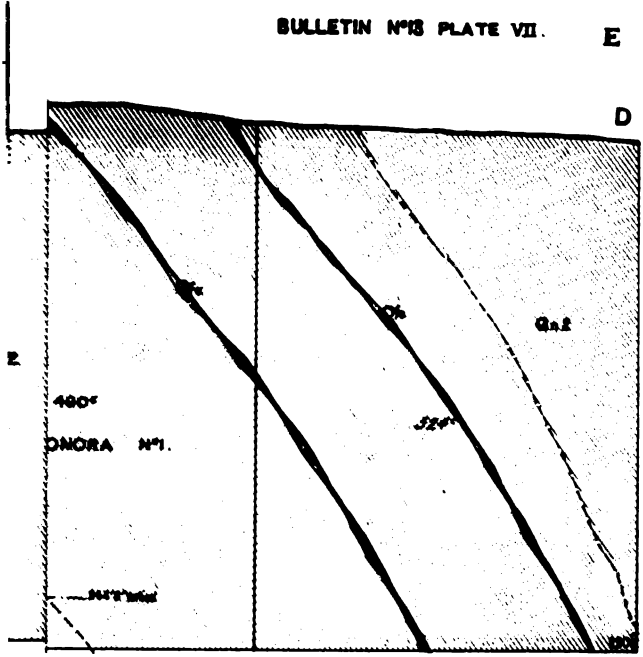
The deposit is worked from a main inclined shaft by means levels driven roughly at intervals of 100 feet, the lowest at prese being the No. 12, at a vertical depth of 1,056 feet.

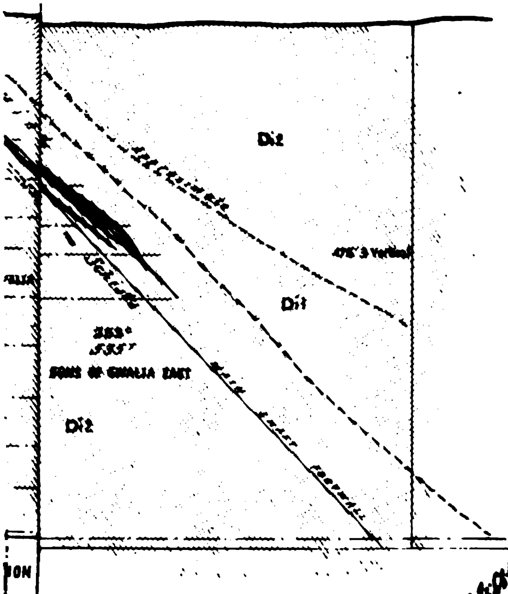
The upper portion of the shaft approximately followed t main shoot, but owing to the somewhat flatter dip at a great depth that ore body is now considerably to the east; and a ma crosscut from the shaft is necessary to intercept it. The crosscu are continued east until what is termed an "indicator vein" is me with—a small vein or string of quartz containing values, an apparently connected with the main shoot—and this is followe towards the south until the drive is carried into the main ore lens.

In order to save driving in the three lower levels a south easterly direction has been given to the main crosscuts immediatel on leaving the shaft.

The upper levels have been driven to the apparent limits of th ore, both to the north and south, but no very extended prospectin appears to have been done in search of an extension of the deposit, or the existence of another shoot, which, towards the north, is still

BULLETIN No 13 PLATE VII.





...soft NORTH OF SONS OF GWALIA SHAFT

Fig 5

A. Gibb Maitland
Government Geologist

D.H. Lower del.

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a matter of conjecture, though some light is afforded on the question of an extension of the lode southwards by an examination of the workings of the Gwalia South Mine. (Fig. 2, Plate VII.)

What appears without doubt to be a continuation of the Sons of Gwalia lode is being worked at a depth of about 187 feet; which would be at a level between the No. 2 and No. 3 in the Sons of Gwalia mine. At this point the shoot is considerably farther west than would have been expected, and has, moreover, assumed a course somewhat more east of north. There is also another small shoot about 80 or 90 feet east, the course of which, as far as can be judged from the workings, trends even more to the eastward; and if it continued thus would pass at this level into leases 380c and 353c. The ore bodies can only be examined in one place, however, and the surface is covered by the tailings dump and slimes pits. (Plate VIII.)

The ore, even in the most quartzose portions, has a crushed appearance, and portions of it separate along parting planes in which are thin laminæ of chloritic schistose material, often showing thin gold on the surfaces. An examination of samples by Mr. E. S. Simpson, the Departmental Mineralogist, has shown that in addition to the predominating quartz and pyrites, calcite chlorite muscovite and acicular tourmaline are present as associated minerals.

When passed through the mill, the resulting pulp from which about 65* per cent. of the gold is obtained by amalgamation, contains 53* per cent. of sands, 45* per cent. of slimes, and 2* per cent. of concentrates. The concentrates are reserved for separate treatment.

The sands and slimes, after leaving the concentrators, are elevated to spitzkasten, which returns to the machines a certain per cent. of coarse sands and concentrates; the remainder passing to the collecting vats, the slimes through slat-grates to the settling dam.

The sands collected in the vats, after being treated with a preliminary wash, are dumped into other vats beneath, and given appropriate cyanide treatment. The concentrates collected from the tables are ground in wheeler pans, and pass thence to agitators, when, after filter-pressing the resulting product of agitation with cyanide solution, a good extraction is said to be obtained, or, summing the various processes, a total extraction of 85* per cent.

The ore is mined and thus dealt with by 50 stamps, with a duty of 5·5 tons, and at a cost to the company of £1 0s. 7d.* per ton.

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* Figures supplied by manager, August, 1903.

THE EASTERN
(*Gwalia South*).

Lease.	Total Ore.	Total Gold.*	Average Grade.
	tons.	ozs.	ozs.
No. 198c	302	363·17	1·20

* To end of 1903.

The lease is situated immediately to the south of the Sons of Gwalia, No. 190c, and adjoining it.

The outcrop was discovered shortly after the Sons of Gwalia by a prospector named Duffil, and a lease taken up, which, however, was chiefly under exemption or only worked intermittently until the end of 1902, when the present company was formed in Melbourne.

The deposit is situated in the schists, in a precisely similar manner to the Sons of Gwalia, of which, as already explained, it is no doubt an extension; and is limited in width on the east by a similar mass of greenstone, also, probably, a continuation of that already mentioned.

The character of the lode formation and the ore are also identical, the latter being sent for treatment at the public battery.

The development work on the lode amounts to 207 feet of sinking, shaft and winze, and about 116 feet each of crosscutting and driving, the deepest level being at 187 feet.

The workings are situated 236 feet from the boundary, so that, if the lode continues at its present dip to the east, it will, as a depth is reached, pass out of the lease into the Sons of Gwalia Extended, Nos. 584 and 380, held by the Sons of Gwalia Company.

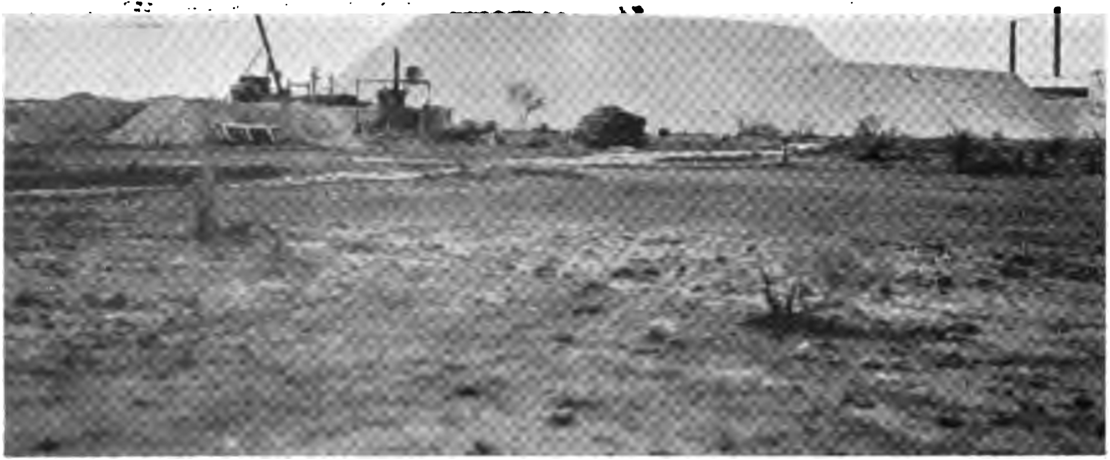
So far, however, it has only been explored at the northern end of the lease, which is 12 chains square.

Farther south, a considerable amount of prospecting has been done in search of a continuation of this lode, and leases were taken up and shafts sunk for more than two miles; but no work has been done for some years, and it is difficult to collect facts, either with regard to the extent of the operations or the success met with.

It is advisable, however, in a report of this kind, to record the information obtained, and most interest attaches to the leases known as the "Star of Gwalia" and "Star of Gwalia South":—

THE STAR OF GWALIA AND STAR OF GWALIA SOUTH (LEASES NOS. 478c, 479c).

These leases are situated half-a-mile almost due south of the Sons of Gwalia, and were taken up and prospected, I believe, by Mr. G. W. Hall. It is said that, both by sinking and with the aid



The Gwalia South Mine working the Southerly Extension of the Sons of Gwalia Lode, showing relative position of two Mines.

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of diamond drills, the country was explored to a depth of at least 1,500 feet, and in the Star of Gwalia there were crosscuts at water level from the east to the west boundary of the lease, without success as far as the Gwalia lode was concerned, or indeed a payable formation.

What has no doubt been the deepest shaft, on Lease 479c, appears to have been sunk on the same zone of massive rock met with in the workings to the east of the Sons of Gwalia lode, which it entered at a depth; and while it is not surprising that the shallower shafts did not intercept the lode, if it exists, it appears most probable that the deeper efforts were mis-directed by an expectation of finding it considerably farther east than might now be expected: a supposition to which the evidence from its appearance in the Gwalia South mine strongly points.

Immediately to the north of the Sons of Gwalia there have also been a number of leases taken up and shafts sunk in the greenstone schists, of which, however, but little information is obtainable.

THE ROCHESTER (LEASE No. 450c).

This lease is situated 36 chains north of No. 190c, and a shaft was sunk by an Adelaide company, I believe, to a depth of 300 feet, but without any result. It is now held by the Sons of Gwalia Company, and used by them as a water supply shaft.

North of the townsite of Leonora are further deposits in the greenstone, some of which, like those of lesser importance to the south, are only worked intermittently or abandoned.

THE SAVANAH.

Lease.	Total Ore.	Total Gold.*	Average Grade.
	tons.	ozs.	ozs.
Nos. 621c, 786c, etc. ...	121	85·98	0·71

* To end of 1903.

No. 621c and the original leases, 786c, 787c (now voided), are situated about 75 chains north-west of Leonora, on the eastern side of the Lawlers Road.

There are shallow shafts and workings for more than a mile along the line of reef, but work has never been more than superficial and intermittent.

The deposit occurs in the greenstone schists, with a corresponding strike of 32 degrees west of north, the dip of 70 degrees being to the east. It is not very large, its chief characteristic being in the ore, a highly ferruginous banded quartz, which has already been mentioned in connection with its relation to the larger masses of similar variety.

THE GREAT BOSTON.

Lease.	Total Ore.	Total Gold.*	Average Grade.
	tons.	ozs.	ozs.
No. 546c	279	113·45	0·40

* To end of 1903.

This lease is situated a mile north-west of Leonora, on the western side of the Lawlers Road. It has been abandoned for some years, so that little information with regard to it can now be obtained.

There appears to have been a deposit of the character of a "lode formation," and some extensive development work was undertaken by Mr. G. W. Hall, especially at the 120 feet level, where some long crosscuts were put in; but considerable quantities of water were met with, and the gold yield shows that the ore obtained was of low grade.

The option held by Mr. Hall was abandoned, and no further work has since been done. The lease is now held by the Sons of Gwalia Company as a reserve water area.

THE COMMONWEALTH.

(*Grey Lode.*)

Lease.	Total Ore.	Total Gold.*	Average Grade.
	tons.	ozs.	ozs.
Nos. 954c (711c) (556c) ...	199	85·60	0·37

* To end of 1903.

These leases and others have been taken up and forfeited at different times, enclosing the same area, but with corner pegs in slightly altered positions.

No. 954c, now known as the Commonwealth, is situated one and a-half miles north-west of Leonora, and the deposit, which was one of the first worked in the district, has received only occasional attention from different prospectors.

The reef is in the greenstone schists, having a strike about 9° west of north, and an average easterly dip of 35°. The quartz composing it has a greyish colour, and varies from one to four feet in thickness, with a considerable proportion of sulphides even near the surface.

An underlay shaft follows the reef for about 40 feet, in which distance it appears to be faulted in two places, and the eastern portion dropped about 10 feet. There are, besides, several vertical shafts sunk on the back of the reef, and the prospectors working there at present intend to sink another to intercept it at a rather shallower depth.

THE LEONORA GOLD BLOCKS.

Lease.	Total Ore.	Total Gold.*	Average Grade.
Nos. 195c, 196c	tons. 6,144	ozs. 9,740·53	ozs. 1·58

* To end of 1906.

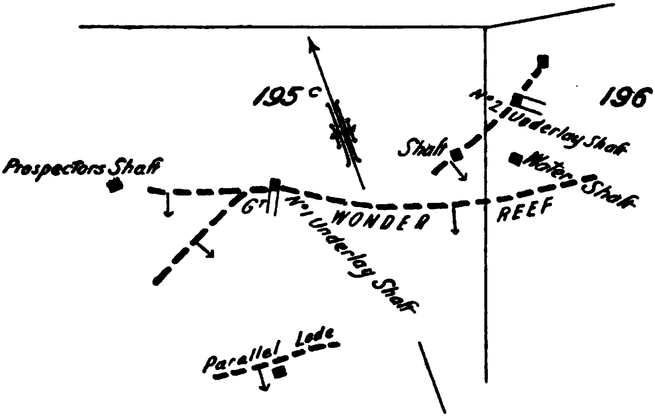
The leases are situated just to the east of the Lawlers Road, four miles north-west of Leonora, and the deposit was one of the first discovered in the district, in 1896.

Lease 195c was taken up on the 3rd June, 1896, by a prospector named McPhie, an employee of a Perth syndicate, who are the present owners of the property.

Only one or two small pieces of quartz were found near the outcrop, the actual discovery of which is attributed to a black boy attached to McPhie's party; and the reef was afterwards located beneath the cement.

Two main reefs have been opened up, situated in an area of massive and crushed greenstone, and on Leases 195c and 196c (Fig. 5).

FIG. 5.



PLAN SHEWING POSITION OF PRINCIPAL REEFS LEONORA GOLD BLOCKS.

That situated on Lease 195c, originally known as the Great Wonder, was worked from the No. 1 underlay shaft, and has a mean strike of about 10 degrees south of east, but there are several curves and branches.

As exposed in the shaft, the deposit consists of a quartz vein, centrally situated in a zone of crushed greenstone, which contains smaller parallel quartz veins; and the whole formation, which dips at 55 degrees to the south-west, is enclosed by almost parallel walls of massive greenstone.

The zone of crushed rock, with a width in one part of the shaft of about two feet and in many parts of the workings considerably more, is decomposed and mineralised.

The character of the reef on Lease 196c, which is being worked at present from No. 2 underlay shaft, is somewhat similar, except that the containing rocks are completely foliated. Its approximate strike is about 15 degrees north of east, the dip from 25 degrees to 30 degrees to the south of east; the main quartz vein and the accompanying formation have a payable width of from one to three feet.

Its form, however, is very irregular, and being interfoliated with the greenstone it follows the contortions of the rock, and not unfrequently splits up into two portions, which for some distance follow different parting planes. Often a kind of saddle is formed, and in such cases the upward and downward legs are generally found to be rich, while the ridge or cap is impoverished. When the deposit splits in this manner, it is sometimes difficult to know until some work has been done which is the branch and which the main vein, as the former sometimes contain high values.

Passing through the workings are two felsite dykes, which can be traced on the surface with a parallel course from the south-east to the north-west corner of the lease, and have a width of from 15 to 20 feet.

Known as "white lodes," they dip to the east at about 60 degrees, their strike being almost at right angles to the direction of foliation of the greenstone.

The continuity of the reef, however, is not broken, and at the intersection the felsitic rock is said to be mineralised and auriferous for a small distance on either side of the vein.

Outcrops of similar rock are to be seen on the surface to the south and the north, but it is not possible to trace them for any great distance, owing to the prevailing superficial deposits. While the general characteristics are those of a dyke, and the rock slice of the least decomposed specimen obtainable has the appearance of a felsite, the subject cannot be left without reference to the innumerable metamorphosed varieties of the greenstones found elsewhere, one form somewhat similar to the rock in question, and to which a connection might possibly be traced when further information is obtainable.

Quite recently another reef carrying gold was discovered and a lease taken up just to the south of the Leonora Gold Blocks, and in addition to the two already mentioned there is another reef on

Lease 195c, known as the "parallel lode," from its approximately similar course to that of the Great Wonder. The dip is also in the same direction, but the vein is highly inclined and the outcrop is about four chains west of the No. 1 underlay shaft.

Messrs. Bewick, Moreing, & Co. commenced the work of sinking a diamond drill bore to the west of this outcrop, the intention apparently being to intercept both this reef and the Great Wonder; but there is no information obtainable either with regard to the results obtained or as to whether the intention was ever completely carried out.

There has been a considerable amount of development work, especially from the No. 1 underlay, which follows the dip of the vein for 150 feet, and from which levels have been opened out both east and west at 50 feet, 95 feet, and 150 feet; in all about 1,300 feet of driving.

Development from the No. 2 underlay shaft is being chiefly carried on at a level corresponding to the upper one on Lease 195, the intention being to connect the two and ascertain whether the reef is a branch of the main reef. A number of shafts have been put down by prospectors at the north-west corner of Lease 195, in search of a continuation of the Great Wonder, but without success, the majority of them being sunk in the granitic rocks to the west.

So far the ore, nearly all obtained from the oxidised zone, has been amenable to treatment without special appliances; but, at a greater depth, it appears that its character will be that of a sulphide ore. The bulk of that obtained has been dealt with at the mine by a 10-stamp battery, working at present with a duty of 2·7 tons, and there is a small cyanide plant attached.

THE CLARENCE.

Lease.	Total Ore.	Total Gold.*	Average Grade.
	tons.	ozs.	ozs.
Nos. 908c (731c) (465c) ...	314·75	521·49	1·65

* To end of 1908.

The leases are situated five miles north-west of Leonora, and about half-a-mile from the Lawlers Road, on the east side. The original prospectors of the claim, in 1897, were Messrs. Adams, Ferry, and Boatright, by whom it was abandoned, and shortly afterwards a considerable amount of gold was obtained by other prospectors.

There are three veins or reefs, having an approximate parallel strike of 52 degrees east of north, and a southerly dip varying from 45 degrees to 85 degrees. The rock in which they occur is in the upper portions decomposed and completely converted into a clay, which in places shows evidence of an original schistose structure and has no doubt been derived from a basic rock.

The centrally situated of the three veins is that on which the most work has been done, and there are a number of shallow shafts and surface workings along the outcrop; but the bulk of the prospecting was done from a vertical shaft which cuts the reef at a depth of 60 feet, just above water level. The vein has a lenticular habit; and the ore, essentially a quartz, shows often a good deal of free gold.

The second parallel vein of the same character which has been recently opened up is about 50 feet south, and though small, has returned good results.

THE RICHMOND.

Lease.	Total Ore.	Total Gold. *	Average Grade.
	tons.	ozs.	ozs.
No. 730c	124	137·31	1·10

* To end of 1903.

This lease is situated just to the west of the Clarence, and almost adjoining it; five miles north-west of Leonora.

The deposit, which is of similar character, was discovered in 1897 by Messrs. Ferry and Pain, and has also a strike of 25 degrees east of north and a southerly dip of 65 degrees.

The prospectors sunk a shaft to a depth of about 65 feet, and stoped all the payable ore they could find above water level.

CLIFTON HILL.

Lease.	Total Ore.	Total Gold. *	Average Grade.
	tons.	ozs.	ozs.
No. 689c	104	76·62	0·73

* To end of 1903.

The lease is situated half-a-mile east of the Clarence, five miles north-west of Leonora.

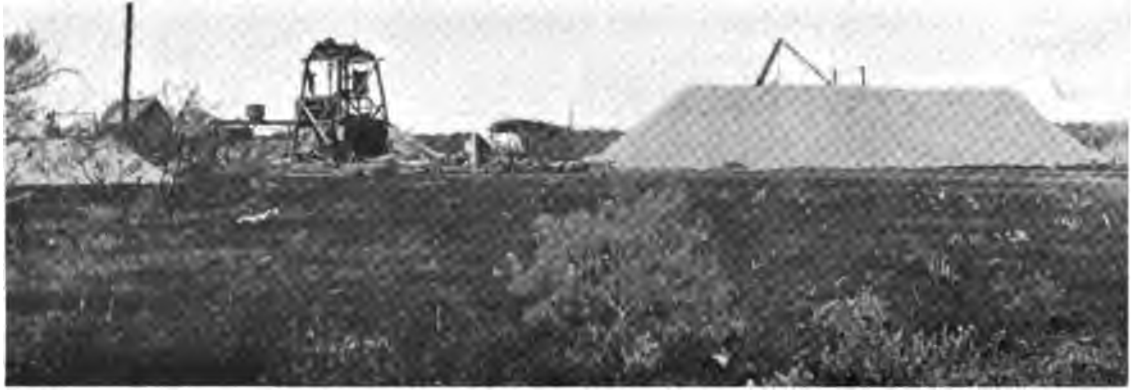
There are two quartz veins in the foliated greenstone with a strike of about 45 degrees and 10 degrees west of north respectively, and an average underlay to the east. They were discovered by a prospector named Vetter, and have been worked intermittently by shallow shafts along the outcrop.

PRIDE OF LEONORA.

(*Ironstone.*)

Lease.	Total Ore.	Total Gold.	Average Grade.
	tons.	ozs.	ozs.
No. 618c	1,213	1,152·86	0·95

* To end of 1903.



The "Ironstone" Mine, showing white kaolin and surface covered with clay ironstone.

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The lease is situated four miles north-east of Leonora, and the original discoverers of gold at the spot in 1898 were Messrs. Goodall and Williams. The property is now locally owned and worked.

The deposit is in the granitic schists, and is the most important of those which have been classed as a fourth and separate series in the district; having many features of interest, but on the whole not as productive as others described.

The rock containing them—originally a micaceous schist as already stated—contained, as well as plagioclase felspars which are so much more subject to kaolinisation than the potash varieties, an iron-bearing mineral in the form chiefly of white mica; and the anhydrous or lower-hydrated mica becoming hydrated, with at the same time an increase of bulk, has been a factor tending to a rapid weathering.

Decomposition has extended to a very great depth, and the rock become converted into a white kaolin-like clay. The process, moreover, taking place with an insufficient supply of oxygen, has further resulted in a solution of certain of the ferriferous salts; which in the joints and vein-fissures, and where a small supply of oxygen might be met with, have been re-deposited in the form of an insoluble sesquioxide, thus producing the characteristic brown coating of the quartz veins in the formation, and ultimately giving rise to the large quantities of ferruginous clay ironstone referred to already on the surface (Plate IX.).

The main vein on lease No. 618, with a strike of 23 degrees west of north, has an easterly dip of 50 degrees; and has with the accompanying ferruginous matter been stoped in many places for a considerable thickness.

The prospectors worked by shafts chiefly on the outcrop, but it is the present intention to intercept the vein by a vertical shaft, which has now been sunk to a depth of 180 feet; and in the material obtained from the bottom of this shaft, though some of the white mica is still showing white and intact, an original schistose structure is only just apparent.

This is the deepest sinking yet undertaken in the formation, hitherto only prospected above water level, and further developments will no doubt furnish many results important in connection with the value of the deposits generally.

About 10 chains to the west is a small vein which is being opened up on lease No. 850c., and this, though smaller and the quartz less ferruginous, is similar in most of its characteristics to that at the Pride of Leonora, the containing rock being similarly decomposed.

ASHLEY'S UNITED.

Lease.	Total Ore.	Total Gold.*	Average Grade.
No. 679c	tons. 343	ozs. 421·61	ozs. 1·23

* To end of 1903.

The lease is situated 4½ miles east-north-east of Leonora, and was originally known as "Ashley's Find." The deposit was discovered shortly after the Forrest reef by some of the original prospectors.

The gold from Ashley's United has been obtained from two quartz reefs which have a strike in an east and west direction; the dip being at a fairly high angle to the north; and these veins are supposed, by prospectors working there at present, to be leaders from a main reef lying to the west. There is a highly ferruginous mass outcropping to the west, which contains quartz, and shows gold by dollying even in the ferruginous portion, but in that case it is generally a film on the parting surfaces.

The quartz veins vary from three inches to 18 inches in thickness; and with the surrounding iron oxide and clay ironstone, which also contains gold, have formed an ore body of much greater width, which has been stoped in places from water level to the surface—about 60 feet.

Just to the east of Ashley's United is a group of old leases which were, no doubt, taken up on account of the alluvial deposit, the "Specking Patch" already referred to (page 20). Several shafts were sunk, and I believe a little gold obtained from some small quartz veins with a north and south strike and an easterly dip.

In connection with the deposits in the granitic schists, a lease situated about 1½ miles north-west of the Ironstone and outside the area of the map cannot be overlooked.

THE SONS OF AUSTRALIA.

Camel Leases.

Lease.	Total Ore.	Total Gold.*	Average Grade.
No. 914c (526c)	tons. 680·50	ozs. 963·72	ozs. 1·41

* To end of 1903.

The prospectors most identified with the Sons of Australia were Hurkett and party, who sank several shafts, one at least to a depth of more than 100 feet. The deposit is in a similar formation to that at the Pride of Leonora and Ashley's United.

LEASES OF MINOR IMPORTANCE.

Voided Leases and Sundry Claims.

In addition to those referred to in detail, there are a great number of other leases which have no geological importance, in that they present no structural features of especial note, and which, in fact, have only an interest in so far as they have added a small increment to the total production of the district. The particulars of each are tabulated hereunder.

The total production of all leases in the Leonora district has already been stated in the opening paragraphs of that portion of the report referring specially thereto.

PRODUCTION OF LEASES OF MINOR IMPORTANCE.

	Lease No.	Total Gold. *a*	Average Grade.
		ozs.	ozs.
All Nations	886c	33·50	0·56
British Legation	795c	7·75	1·10
Clean Sweep	820c	17·55	5·85
Comet	522c	66·54	1·41
Croydon	585c	51·26	0·28
Easter Gift	769c	2·65	0·18
Fitzgerald's Amalgamated	708c	9·15	0·18
Flanders	562c	10·40	0·44
Grey Lode	704c	19·09	0·29
Gwalia Gem	558c	42·26	0·52
Kruger Steyn	796c	85·75 *b*	...
Lady Lena	508c	37·40	1·55
Lady Lena North	520c	44·08	1·27
Lady Muriel	984c	59·30	0·28
Last Chance	990c	6·57	0·15
Little Dorothy	992c	43·91	1·16
Mt. George Battery	92/5c	2,175·43 *c*	0·82
New Year's Surprise	826c	93·25 *d*	3·29
North Riviera	818c	6·00	0·60
Ottawa	771c	14·75	0·52
Otterburn	354c	2·16	0·86
Pride of Leonora North	649c	6·45	0·35
Royal Flush	931c	116·64 *e*	3·18
Riviera	802c	157·29 *f*	1·17
Rajah	455c	36·95	1·98
Reliance	589c	97·33	0·53
St. Helliers	952c	16·95	0·80
Scallywag	577c	3·00	0·50
Sheffield	725c	37·85	2·32
Supreme	772c	5·05	0·42
Turn of Tide	625c	3·89	0·85
Victor	835c	307·48 *g*	1·27
Warragamba	1008c	36·95	0·53
Westralian Broken Hill	1006c	8·02	0·22
Wyangle	627c	4·56	0·86
Sundry Claims	...	1,484·44	...

a To end of 1903. *b* Includes 11ozs. from specimens. *c* Includes 25ozs. from specimens. *d* Includes 1oz. from specimens. *e* Includes 78·44ozs. from specimens. *f* Includes 115·19ozs. from specimens. *g* Includes 225·34ozs. from specimens.

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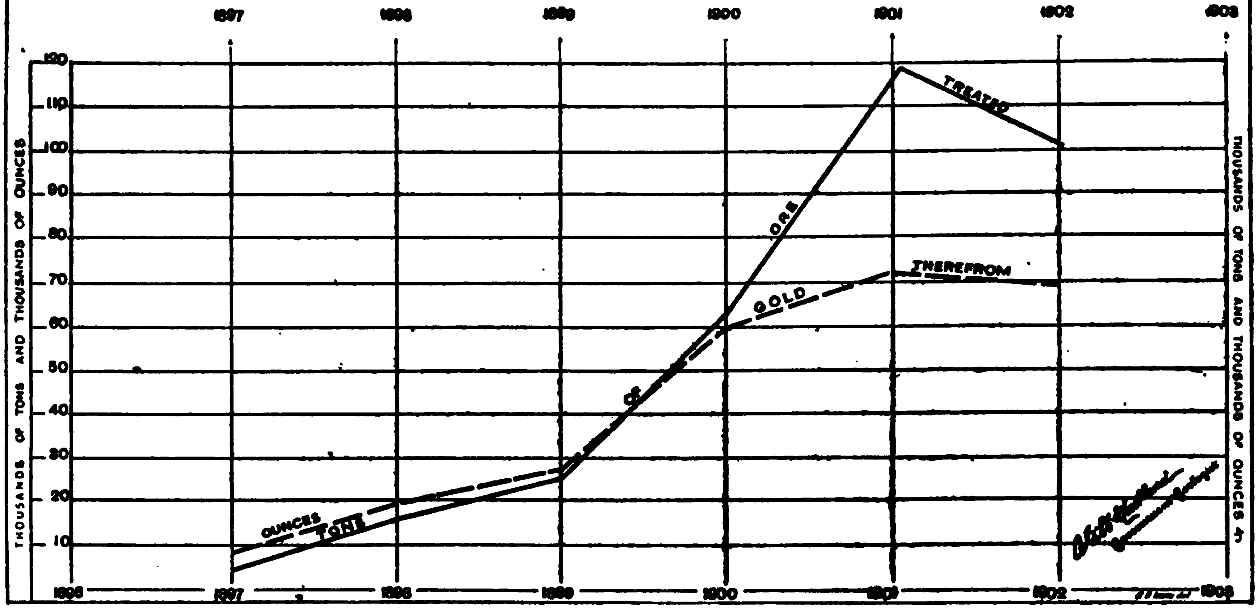
APPENDIX I

LEONORA DISTRICT

ORE VALUE DIAGRAM

Shewing No of Tons of Ore treated and No of Ounces of Gold obtained therefrom for each year since 1897



APPENDIX II.

DESCRIPTIVE REGISTER OF SPECIMENS
FROM THE
LEONORA DISTRICT.

Register Number.	Slice Number.	Rock.		Obtained from—	Locality.
		Field Type.	Variety.		
5217	420	Greenstone	Massive	Outcrop	500 yards S.S.W. of Mount George
5088	405	Greenstone	Massive	Outcrop	Tower Hill Lease No. 4387
5099	413	Greenstone	Massive	Outcrop (weathered)	¼ mile north of Pride of Leonora Mine
5220	424	Greenstone	Crushed	Outcrop	¾ mile S.S.W. of Mount George
5221	425	Greenstone	Crushed	Outcrop	500 yards S.W. of Mount George
5092	407	Greenstone	Foliated	Mine	Sons of Gwalia, East Crosscut
5093	408	Greenstone	Foliated	Mine	Do do do
5216	421	Greenstone	Foliated	Mine	Do do do (No. 3 level)
5215	419	Greenstone	Foliated	Mine	Do do do (No. 7 level)
5105	418	Greenstone	Foliated	Mine	Do do do (No. 9 level)
5090	...	Greenstone	Schistose	Outcrop (weathered)	Tower Hill Lease No. 4388
5087	404	Greenstone	Schistose (chlorite)	Outcrop	Do do No. 4390
5089	...	Greenstone	Schistose (talc)	Mine	Do do No. 4387
5091	...	Greenstone	Altered	Outcrop (weathered)	Do do No. 4388
5218	422	Greenstone	Altered	Outcrop	¼ mile east of Mount George
5219	423	Greenstone	Altered	Outcrop	Do do do
5104	...	Greenstone	Altered	Outcrop	Do do do
5226	...	Greenstone	Altered	Outcrop (weathered)	Do do do
5086	...	Greenstone	Altered	Outcrop (weathered)	Do do do
5098	412	Greenstone	Diabase	Outcrop	Near junction of telegraph lines, N.E. of Leonora
5082	401	Granite	Crushed	Outcrop	Near Trig. Station, Mt. Leonora
5083	402	Granite	Crushed	Outcrop	Do do do
5084	...	Granite	Crushed	Outcrop	Do do do
5085	403	Granite	Crushed	Outcrop	Do do do
5100	414	Granite	Crushed	Outcrop	Do do do

5094	409	Granite	Crushed	Outcrop	N.E. side of Lawlers Road, near Trump Mine
5224	428	Granite	Crushed	Outcrop	South of Leonora Main Reefs Lease 253c
5225	429	Granite	Crushed	Mine	Leonora Main Reefs Lease No. 210c
5097	411	Porphyry	Crushed	Outcrop	East of Mt. George telegraph line 74¼ miles
5096	410	Porphyry	Crushed	Outcrop	400 yards west of Pride of Leonora Mine
5095	...	Granite	Schistose	Outcrop (weathered)	Near road from township to Pride of Leonora
5370	...	Granite	Schistose	Outcrop	East of Sons of Gwalia Lease 525c
5227	...	Mica Schist	...	Shaft	Lease No. 537c
5231	...	Schist	With Granular Graphite	Shaft	Lease No. 887c
5373	...	Earthy Travertine	"Cement"	Surface	Tower Hill Lease No. 4390
5371	...	Siliceous Limestone	...	Trench	East margin Lake Raeside, west of Gwalia
5288	431	Siliceous Rock	Re-cemented	Outcrop	West margin Lake Raeside, west of Gwalia
5101	415	Quartz	Banded	Outcrop	Lease No. 523c
5102	416	Quartz	Banded	Outcrop	Lease No. 523c
5222	426	Quartz	Banded	Outcrop	Trig. Station, Mt. George
5372	...	Quartz	Banded	Outcrop	Lease No. 786c (Savanah)
5103	...	Quartz	With Ferriferous Dolomite	Outcrop	Tower Hill Lease No. 4388
5223	...	Ore	Typical Specimen	Mine	Tower Hill Lease No. 4390
5229	...	Ore	With Acicular Tourmaline	Mine	Sons of Gwalia
5369	...	Ore	Typical Specimen	Mine	Do do
5230	...	Ore	With Asbolite	Mine	Leonora Main Reefs
5232	...	Ore	Typical Specimen	Mine	Trump Lease No. 263

C. F. V. JACKSON,
Assistant Government Geologist.

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The Figures in Italics refer to Plates and Diagrams.

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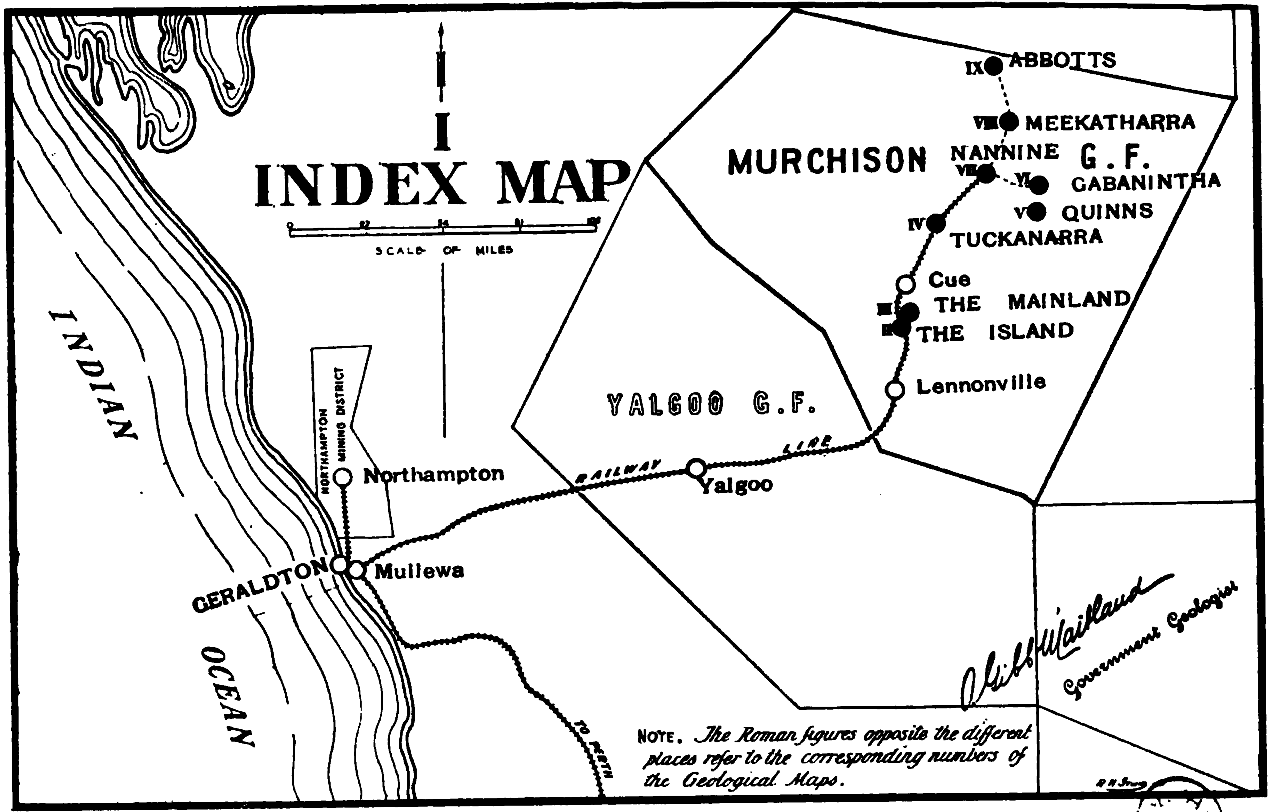

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A. Gibb Maitland
Government Geologist

UNIV. OF MICH.

1904.

WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 14.

The Geology and Mineral Resources of a part of the MURCHISON GOLDFIELD,

BY

CHAS. G. GIBSON, B.E.,
ASSISTANT GOVERNMENT GEOLOGIST.

Issued under the authority of the Hon. H. Gregory, M.L.A., Minister for Mines.

WITH NINE MAPS AND EIGHT FIGURES.

PERTH:
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1904.

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PREFATORY NOTE.

IT was considered desirable, in view of the light conferred by the results of the Geological Survey of Lennonville, Mount Magnet, and Boogardie, carried out in 1903, that the northern extension of the Murchison Auriferous Series, in the direction of Abbotts, should be undertaken.

The report and accompanying maps represent the results of Mr. Gibson's investigations in this northern portion of the Murchison, and include descriptions of the mining centres of Lake Austin, Tuckanarra, Quinns, Gabanintha, Star of the East, Nannine, Meekatharra, Abbotts, and the Wilgie Mia, Weld Range, in addition to a short account of the country traversed between the different localities.

The field work upon which Mr. Gibson's observations are based was commenced on the 24th of August and completed on the 12th of December, with but a short interruption, when it was found necessary for him to return to Perth for about a fortnight.

The Murchison is of some historical interest in that, in the year 1855, when the economic value of the district as regards its mineral resources was entirely prospective, it was officially set forth in a report to the Government that the country to the east of the Murchison River had every appearance of being one of the finest goldfields in the world. While it cannot be said that the district (which constitutes one of the most important auriferous regions of the State) has come up to the high expectations then formed of it, still the Murchison does possess what is believed to be the largest solid quartz reef yet mined anywhere—the Great Fingall Reef at Day Dawn—and the phenomenally large and rich iron ore deposits of the Wilgie Mia, in the Weld Range.

The Murchison rose from the position of a pastoral district in the year 1891, when the first gold find of any real importance took place at Nannine. Gold was, however, discovered in 1888, a few miles to the north of what is now the mining centre of Cuddingwarra, but the find attracted but little attention. Since the first discoveries of gold, operations, despite many causes which stood in the way of mining development, have been carried out in the Murchison district, which, including Yalgoo, has been responsible for 1,122,625·97 ounces of the State's total output of gold at the close of the year 1903. There is every reason to believe that this portion of Western Australia will continue to be a prominent gold producer, and that the output will materially increase.

The geological structure of the portion of the Murchison District embraced by Mr. Gibson's work is remarkable for its uniformity. The district may be described as a series of persistent zones of schists and allied metamorphic rocks, which everywhere constitute what may be called the Auriferous Series. These zones of schists are surrounded by granite, which the evidence accumulated during the progress of the field work would seem to indicate belong to two distinct periods, viz.: an older, which has been subject to the shearing, etc., which affected the schists; and a newer, which penetrates the older granite as well as the Auriferous Series.

The greenstone schists are remarkable for their persistent strike and horizontal extent, one belt alone having been proved to extend for at least sixty miles. So far as observations have at present been carried, the schists appear to be merely sheared and foliated igneous rocks. By far the larger portion of Mr. Gibson's duties, however, were of necessity devoted rather to economic than to stratigraphical geology, hence it has not been found possible to devote very much time to the solution of the exact relation of the different greenstones to one another, and such other cognate points. It is quite conceivable that much more detailed research than has hitherto been found possible would result in the recognition of highly metamorphosed sedimentary beds among the foliated greenstones of the Murchison.

Two distinct types of auriferous deposits have been shown to occur in the North Murchison, viz.: the laminated quartzites (which often contain hæmatite to such an extent as to warrant their being classed as iron ones) and the pure quartz reefs.

The quartz reefs occur in the granite, in addition to the greenstones and allied rocks, but it is only those in the latter that have proved to be auriferous to any extent; those occurring in the granite have invariably proved to be of too low a grade to be successfully worked under present conditions.

The quartz reefs occurring at or near the junction of the greenstones and the granite appear to be unusually large and well defined, and outcrop for considerable horizontal distances, whilst the gold contents appear to be more uniformly distributed throughout the body of the reefs than in those associated with the quartzites.

The quartzites form one of the most characteristic features in the district; they are everywhere confined to the greenstones, and extend as roughly parallel bands, many miles in length, and outcrop in the form of rough serrated ridges. The beds vary from almost pure quartz, through varieties of banded jaspers, often of great beauty, to practically pure banded hæmatites, some of which (notably those in the Weld Ranges) might be turned to profitable account as sources of iron ore, under more suitable conditions. The quartzites are not, as their name (under the present somewhat unsatisfactory system of nomenclature) implies, of sedimentary origin, but are merely quartz reefs of a peculiar type. The quartzites themselves are not, as a rule, highly auriferous, except in those places where they are traversed by ordinary quartz reefs; in which latter case, rich but narrow chutes of gold occur.

So far as observations have at present been carried out, within the area examined by Mr. Gibson in the North Murchison, very few workings extend below a vertical depth of 300 feet from the surface.

The following table shows the total gold returns from the mining centres examined, up to the end of 1903:—

	Ore treated. tons.	Gold therefrom. ozs.	Average Grade per ton. ozs.
Lake Austin	34,483·40	71,328·62	2·07
Tuckanarra	11,689·75	15,273·50	1·30
Munarra Gully	13,115·50	8,059·27	·61
Quinns	959·00	1,135·67	1·18
Gabanintha	35,716·75	34,600·15	·96
Nannine	61,955·13	59,002·56	·95
Meekatharra	13,906·33	13,783·09	·99
Abbotts	29,402·00	35,039·01	1·18
District generally	...	*3,087·70	...
Total	203,227·86	†238,221·87	1·17

* Alluvial. † Does not include the alluvial gold.

Considering the number of reefs already proved to exist and those which have been worked with (as shown by the official returns) an average grade of over an ounce to the ton, there are good grounds for judiciously carrying out a more vigorous prospecting policy than has been the case in the past, for the reefs give every promise of being, as a whole, as persistent in depth as such deposits ever can be.

The report and accompanying maps, on being submitted to the Hon. the Minister for Mines, were ordered to be printed for public information.

A. GIBB MAITLAND,
Government Geologist.

Geological Survey Office,
Perth, 28th March, 1904.

THE GEOLOGY AND MINERAL RESOURCES

OF A PART OF

THE MURCHISON GOLDFIELD.

Introduction.

Boundaries of the Field.—The Murchison Goldfield, as originally constituted, was first proclaimed on the 24th of September, 1891. Its boundaries were modified on the 15th of February, 1895, so as to embrace an area of about 21,000 square miles. As defined by the authorities, the goldfield at present is—

> Bounded by lines starting from the summit of Mount Murchison, and extending north-eastward to the summit of Mount Hale; thence east-south-eastward to the summit of Mount Russell; thence south-westward to the north-west corner of the Yilgarn Goldfield (North Coolgardie G.F.?; thence west-north-westward to the summit of Wyemando Hill, and onwards to the trig. station K 6 on Goonamondey Peak; thence north-westward to the summit of Mount Farmer, and onwards to the summit of Mount Luke, and onwards to the summit of Mount Murchison.

Mining Centres examined and mapped.—The centres examined and reported on were Lake Austin (the Island and the Mainland), Tuckanarra, Quinns, Gabanintha, Nannine, Meekatharra, Abbotts, and the Weld Range. Of all these, with the exception of the Weld Range, maps have been prepared on a scale of 20 chains to one inch, showing all geological boundaries, the strike and dip of all reefs and ore bodies, the position of existing leases, and all shafts and surface workings.

Previous Reports on the Murchison Goldfield.—The following extracts have been taken from various official reports which have appeared from time to time on parts of the Murchison Goldfield and on the goldfields of the Colony generally. In the year 1855 Assistant Surveyor Mr. Robert Austin was sent out by the Government to explore a portion of the interior of Western Australia. On his return he published a report [*] entitled "A Report of an expedition to explore the interior of Western Australia," in which he says:—

> . . . . between Mt. Farmer and Mt. Magnet, 150 miles to the eastward of Mr. Gregory's last bivouac on the Murchison, and 300 miles south-east from Shark Bay, I have passed over 70 miles of undulating country presenting chocolate-coloured mica slate hills and felspar and quartz grit cliffs, in association with quartz and hornblende schists, resting on granite breccia and greenstone, surrounded by plains of red loam, covered with quartz stones and rich black iron ore, and shedding to the north-east into the great interior marsh I have discovered flowing to the north-west; that 100 miles east from the bottom of Hamelin Harbour, or the north arm of Shark Bay, at the place we retreated from on the 12th October, there are white cliffs resembling chalk and quartz grit cliffs with egg-shaped quartz pebbles of various sizes embedded in them, resting on dislocated gneiss rocks, intersected by two walls or veins, one of round and the other of angular quartz stones, cemented in a hard greenish white matrix, and surrounded by red loamy plains covered with these angular and rounded stones; that 100 miles south-south-west from this last-named place, and on the left bank of the Murchison, across my track of the 15th and 16th of November, there are similar pebbly cliffs in association or blended with primary schists; that there are pipeclay plains resting on greenstone around the quartz schists ranges in the vicinity of Mt. Kenneth, and similar plains covered with quartz stones at the base of the felspar cliffs, near our bivouac of the 12th of August; and that all the facts I have alluded to under this head show the accuracy of Sir Roderick Murchison's views relative to the formation of the country to the eastward of the Murchison River and at the back of Shark Bay.
>
> I beg to draw your attention to the first and second items as indicative of a fertile country to the eastward; and to the latter as confirmatory evidence in support of an eminent geologist's [†] opinion that we have in this hitherto unexplored and imprudently neglected portion of our territory probably one of the finest goldfields in the world. I have noted many important facts in support of these opinions, which, if you wish me to lay before you, I shall have much pleasure in submitting for your further consideration, as well as a plan for future operations from a central depôt on the great bend of the Murchison. . . . .

In 1863 (?) Mr. E. C. Hargreaves was sent out to examine Western Australia with the view of determining if, as had been loosely asserted, it would prove to be auriferous. After various excursions into the interior he reported in a paper read before the Royal Geographical Society [‡] that, although rich in copper and iron ores, its rocks, so different from those of New South Wales and Victoria, render it essentially a non-auriferous country.

In the discussion which followed the reading of this paper, Mr. Selwyn, the Geological Surveyor of Victoria, is reported to have said that—

> . . . . . Some of the specimens in which Mr. Hargreaves found indications of copper he thought were analogous to rocks of central South Australia, from Mt. Serle to Mt. Remarkable, in which the great copper mines

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[*] Journal of the Geographical Society, vol. 26, 1856, page 36.

[†] Sir Roderick I. Murchison, Director General of the Geological Survey of the British Isles.

[‡] "On the Non-Auriferous Character of the Rocks of Western Australia," by E. C. Hargreaves. Proceedings of the Royal Geographical Society, Vol. VIII., 1864, p. 32.

of South Australia occur. He thought, however, we ought hardly to take an examination of the coast-line as a proof that the whole of Western Australia was non-auriferous, because if we looked at the enormous expanse of Western Australia, it would be seen that Mr. Hargreaves had traversed it to but a very limited extent; and it was not improbable that there might be regions in which the silurian rocks might re-appear.

In 1870, 1871, and 1872, Mr. H. Y. L. Brown was Government Geologist of the State, and during his term of office examined and published reports on a considerable portion of it, including one —accompanied by a geological sketch map—on the country to the north-east of Champion Bay, W.A.* It is apparently from the data contained in these reports that Governor Weld based the following remarks, which appear in a despatch sent to the Earl of Carnarvon in September, 1874:—

> The mineral riches of this colony are very great. I have never doubted but that they would ultimately become a main source of its advancement. All the different kinds of auriferous quartz known in the other colonies are found abundantly in various parts of this; the question of payable gold is, as I have long since reported, simply a question of time.

In 1893, Mr. H. P. Woodward, then Government Geologist, published a report on the Murchison Goldfield.† In this he says:—

> There are four formations on this field, which are—

Recent ...	Alluvium of the watercourses, flats, and salt marshes travertin, and other surface deposits.
Mesozoic (?)...	Desert sandstone, horizontally bedded sandstones, clays, pipeclays, gypsum, and ferruginous beds.
Metamorphic	Slates, schists, quartzite, sandstones (mostly ferruginous), limestone, or granite.
Plutonic ...	Granite, diorite, and other dykes.

> The recent formations are always of very limited thickness, rarely, as far as tested, exceeding 15 to 20 feet. They have been derived directly for the most part from the denudation of the desert sandstones, but also in some cases from the metamorphic rocks. . . . . . The mesozoic formation, if represented by the remains of the old tableland, can be seen well in many cliff sections, but up to the present no organic remains have been found in them; but, to judge from the associated gypsum and iron beds, it is highly probable that some will yet be met with. It is probably a portion of the great plain of the interior of Australia, the age of which has been determined as mesozoic, but until fossils are found we shall not be able to determine their correct age. . . . . . The metamorphic rocks outcrop, rising as low ridges wherever the overlying desert sandstone has been removed; they are mostly hard, large quartz reefs often forming the main axes of the ridge, but more generally beds of highly-altered ferruginous quartzite, nearly approaching a mineral vein in character, at the intersection of which the quartz reefs are always richest. Along the principal belt of auriferous country the rocks for the most part strike a little to the west of north and underlie to the west, consisting largely of talcose and granitic rocks, although hornblendic and micaceous slates are also met with. . . . . . Dykes are met with in many places; these are generally either granite or diorite, the latter being of great variety, whilst the former generally contain crystals of foliated talc in cavities.

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* Report on a Geological Exploration to the north-east of Champion Bay, W.A., by H. Y. L. Brown, Government Geologist.* Perth: By Authority, 1871.

† Report on the Murchison G.F., by H. P. Woodward, Government Geologist, p. 9. Perth: By Authority, 1893.

Mr. S. Göczel, in an official report on the interior gold region of Western Australia,[*] in speaking of the rocks of the district, says:—

> . . . . . The archæan rocks form the basis of the whole great interior tableland. Rising into elevations within the auriferous region, they are sometimes overlaid by cappings and beds of ferruginous grits, sandstones, and conglomerates, which hardly ever attain any considerable thickness. . . . . The old greenstones (diorite, diabase, gabbro), including the schistose and banded features (felspar-amphibolites, schists, etc.), form hills and ranges along gigantic breaks in the archæan strata; they generally also indicate those stretches of country in which gold deposits occur.

In speaking of the rocks of the Nannine district, in the same report, he says:—

> We here again find a break in the archæan earth crust; the subsidence of the portions to the West of that break; the formation of reefs, dykes, fissures, and faults, and also the usual alteration of the country rock along their course. . . . . The country formation is dioritic schist, which near the surface and along the lode is altered into talcose and chloritic schists. Banks of ferruginous jasper or schistose siliceous ironstone are running transverse to the reef, and on the lines of intersection rich chutes of gold ore have been found to occur. . . . .

Mr. Frank Reed, in a report on the "Geological Features and State of Development of some of the Mines in the Nannine District,"[†] refers to the country rock of this district as consisting of—

> . . . . . dioritic schist, which occupies a break in the archæan gneissic granite which occurs in this locality. These dioritic schists . . . are undoubtedly of volcanic origin; but whether occurring as a sedimentary rock redeposited in beds, or in its primary state, it is difficult to determine, as it is quite possible that the schistose form may be the result of tangential pressure on the diorite rocks during an age of extreme volcanic activity and disturbance. In the upper strata the felspar in these schists is frequently altered to chloritic or talcose schist, thereby becoming a metamorphic rock by kaolinisation of the felspar. These dioritic schists are traversed by quartz reefs, having generally a north and south course. . . . .

Mr. Reed has also issued a report on the "Auriferous Veins of the Central Goldfields," which appeared in the Annual Report of the Department of Mines[‡] for the year 1896.

Other official reports referring in part to the geology of the Murchison Goldfield are:—

(I.) The Country between Northampton and Peak Hill, by A. Gibb Maitland, Government Geologist.[§]

(II.) The Country at the Heads of the Sandford and Murchison Rivers, by T. Blatchford, Assistant Geologist.[‖]

(III.) Lennonville, Mount Magnet, and Boogardie, Murchison Goldfield, by Chas. G. Gibson, Assistant Geologist.[¶]

(IV.) The Auriferous Reefs of Cue and Day Dawn, by W. D. Campbell, Assistant Geologist.[††]

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[*] The Interior Gold Region of Western Australia, by S. Göczel. Annual Report of the Department of Mines for year 1894.

[†] Report on the Geological Features and State of Development of some Mines in the Nannine District, Murchison G.F., by Frank Reed. Annual Report of the Department of Mines for the year 1895, p. 44. Perth: By Authority.

[‡] Report on the Auriferous Veins of the Central Goldfields, by Frank Reed. Annual Report of the Department of Mines for the year 1896, p. 29. Perth: By Authority.

[§] Annual Report of the Geological Survey for the year 1897, p. 14. Perth; By Authority.

[‖] Annual Report of the Geological Survey for the year 1898, p. 36. Perth: By Authority.

[¶] Geological Survey, Bulletin 8. Perth: By Authority, 1903.

[††] Geological Survey, Bulletin No. 7. Perth: By Authority, 1903.

Early History of the Murchison Goldfield.*—The first authenticated discovery of gold within the limits of what is now the Yalgoo and Murchison Goldfields was made in the vicinity of Yuin, near the head waters of the Greenough River. The gold was found in a reef occurring as a blow at a spot about five miles east of Yuin.

The first find of any real importance took place at Nannine in the year 1891, and for this the sums of £500 and £100 were respectively advanced to Messrs. Connelly and Douglas, the discovererers. Before many months there were between 300 and 400 men on the field.

A few years before, viz., in 1888, gold was said to have been discovered a few miles to the north of what is now the town of Cuddingwarra, but it appears to have attracted but little attention.

General Geological Features.

THE GREENSTONES.

The auriferous series of the North Murchison Goldfield consists of massive and foliated greenstones, which are found in belts of varying extent associated with the granites, and comprise pyroxenites, diorites, amphibolites, and altered and schistose forms of these. Some of the belts are of considerable extent; for example, that embracing the mining centres of Mount Magnet, Lake Austin, Day Dawn, and Cuddingwarra, which has been proved to be continuous for at least 60 miles in length, and to have an average width of from 10 to 15 miles; others, again, are of comparatively small area.

The true relation of these greenstones to the main body of the granite is not at present quite clear; it would appear, however, that there have been at least two intrusions of granite, one of which is undoubtedly newer than the greenstones, but whether these latter have been intruded into the main body of the older granite, or the older granite into them, is a question which will necessitate more detailed field work before it can be definitely answered, and will always be rendered difficult owing to the presence of the extensive beds of recent superficial deposits which cover such a large area of the country, and hide all natural sections.

It is within these greenstone belts that, generally speaking, the gold-bearing reefs are always found, payable reefs only having been found in one or two cases on this field in the granite country, viz., at Quinns and Nannine, at both of which places, however, they are of low grade. It is within the greenstones, too, that the belts of hæmatite-bearing quartzites † which form such a characteristic feature of this district occur. In no single instance have these been found in the granite country, a fact which helps to the theory that they are nothing more or less than highly altered bands of greenstone schists.

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* For a somewhat fuller account of the early history of the Murchison Goldfield, *see* Bulletin 8 of the Geological Survey, page 8.

† The name "quartzite" which has been applied to this type of rock is here not used in its strict geological sense, but has been loosely given to them for want of a more suitable term. (C.G.G.)

THE GRANITES.

The granite occurring throughout the district varies considerably both in macroscopic and microscopic properties; that occurring in the southern portion of the field and in the neighbourhood of Mt. Magnet is a biotite granite, while that at Cue, Nannine, Gabanintha, and other more northern centres is a hornblendic variety closely resembling syenite in composition in certain localities (*e.g.*, Cue), and appears to be of later origin than the former variety, and is certainly later than the greenstones, into which it is frequently found intruding.

The following is an analysis of a sample [3796] of this type of rock from the 160ft. level, Agamemnon G.M., Cue :—

Silica, (SiO_2)	63·62	per cent.
Carbonic anhydride, CO_2	*Nil*	
Titanic oxide, TiO_2	·72	„
Ferrous oxide, FeO	3·47	„
Ferric oxide, Fe_2O_3	3·29	„
Alumina, Al_2O_3	14·38	„
Manganous oxide, MnO	·28	„
Magnesia, MgO	3·13	„
Lime, CaO	5·43	„
Ferrous sulphide, FeS_2	*Nil*	
Soda, Na_2O	4·40	„
Potash, K_2O	1·20	„
Hygroscopic water, H_2O	·22	„
Combined water, H_2O	·06	„
	100·20	„
Specific Gravity	2·76	

Analyst ... ... E. S. Simpson.

This rock is a grano-diorite, intermediate between a true hornblende granite and a quartz diorite, the silica percentage being too low for the former and too high for the latter. A section (258) of it under the microscope shows it to consist of—

(*a.*) Felspar, mostly plagioclase (oligoclase) with a little orthoclase; the plagioclases are in large tabular crystals and the orthoclase in clear grains and lumps; the former are, in one or two cases, considerably clouded from the presence of alteration products, principally saussurite. The felspar forms by far the greater portion of the section.

(*b.*) Quartz, fairly plentiful in small irregular grains and lumps.

(*c.*) Biotite, abundant in large flakes and plates.

(*d.*) Hornblende, fairly plentiful, in good sized flakes and irregular lumps; a good deal of it is in parallel intergrowth with the biotite; it is a dark green variety and shows frequent twinning.

(*e.*) Augite: a few small crystals of pale-coloured augite occur associated with the hornblende.

The rock is very similar to that found occurring near Meekatharra.*

The following are four analyses of rocks obtained from Cue during an examination of that district. These analyses were originally intended for use in connection with Bulletin VII.—Notes on the Auriferous Reefs of Cue and Day Dawn, by Mr. W. D. Campbell—but not being available at the time the work went to press had to be omitted, and are now included, as many of the rocks of the district under review bear a remarkable resemblance to those of Cue:—

Geological Museum Number ...	[3832]	[3976]	[3823]	[3847]
Silica SiO_2	50·12	68·46	48·10	48·09
Carbonic anhydride CO_2 ...	·03	2·00	·12	·12
Titanic oxide TiO_2	·26	·61	·41	·12
Water (combined) H_2O ...	·03	·83	·33	2·05
Soda Na_2O	1·95	4·01	2·11	2·17
Potash K_2O	·08	2·05	·14	·07
Magnesia MgO	10·00	2·08	6·38	7·56
Lime CaO	13·04	2·63	12·73	11·30
Manganous oxide MnO ...	·29	Trace	·05	·29
Ferrous oxide FeO	7·01	3·20	4·33	6·99
Ferric oxide Fe_2O_3	1·66	2·27	10·32	1·43
Alumina Al_2O_3	14·90	12·25	15·41	19·77
Ferrous sulphide FeS_2 ...	·13	·15	·25	·11
Water (hygroscopic) H_2O ...	·13	·05	·04	·17
	99·63	100·59	100·92	100·24
Specific Gravity ...	3·02	...	3·11	2·98

[3832] is a hypersthene rock (norite) from a spot on the north side of hill between Lady Forrest and Polar Star G.Ms. Analyst, E. S. Simpson.

[3976] is a felspar porphyry from a depth of 2,030 feet D.D. bore on G.M.L. 226, Day Dawn. Analyst, C. C. Williams.

[3823] is a fine-grained greenstone (amphibolite) similar to that found all over the Murchison Goldfield and is from a spot 9 chains south of Princess Extended G.M.L. 1232, Cue. Analyst, C. C. Williams.

[3847] is a coarse-grained amphibolite from the well on Water Reserve 7745, Cue.

THE HÆMATITE-BEARING QUARTZITES.†

A characteristic feature of the whole Murchison Goldfield is the frequent occurrence of belts of hæmatite-bearing quartzites. These, as has been before stated, only occur in the greenstones, and extend as roughly parallel bands often for many miles, being generally found occurring in the form of low rough ridges and ranges, for, being harder than the surrounding rocks, they have withstood longer the gradual action of weathering; the quartzites are generally auriferous, but are, as a rule, too low grade to be of any commercial importance under present conditions; however, they usually have a very beneficial effect on the quartz reefs in their immediate vicinity, rich chutes of gold being almost invariably found wherever the quartz reefs come in actual contact with or cross them. Frequently these quartzites are crossed by transverse lines of fault, and along these rich pockets of stone are often found.*

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* Page 61. † *See* footnote, Page 13.

The chemical composition of these quartzites varies from almost pure banded blue and white quartz to a practically pure banded hæmatite. They will be found more fully described, with results of analyses attached, under the particular localities in which they occur.

THE SUPERFICIAL DEPOSITS.

Overlying the greater part of the country are beds of recent deposits, which cover the country to depths varying from a few inches to many feet; these result from the gradual weathering of the older rocks, and when derived from and overlying the greenstones are of a fine red clayey nature, but when overlying granite they are lighter in colour and much more sandy.

The ironstone gravel deposits—which are so common throughout the Eastern fields—are not met with to any great extent in this district, and where found are only in very small areas, as the cappings of greenstone hills and ridges.

THE REEFS.

With regard to the reefs of the district, those which occur in connection with the quartzites, though frequently of considerable size, are almost invariably very irregular, and their gold contents are very patchy, small rich chutes, as a rule, being obtained at their point of contact or intersection with the quartzites, while the bulk of the stone is blank or at best of very low grade; the reefs of this class, therefore, are of not much use to a large company, owing to the gold returns being too uncertain, but are frequently very good things for the prospectors, as thousands of ounces are often taken out of one small pocket, and this most frequently very close to the surface. The reefs, which occur wholly in the greenstones and at some distance from the quartzites, are as a rule much more regular, both in size and in their gold contents, and although this is very often found to occur in them in chutes, these are usually of considerable extent. These reefs, generally speaking, give every promise of living to a depth, and if a good many of them that are now abandoned were sunk on and systematically worked to a reasonable depth they would probably give very satisfactory returns. At present practically no work has been done in the North Murchison district below a vertical depth of about 300 feet.

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* *Vide* Report on Boogardie and Mount Magnet, by C. G. Gibson, Assistant Geologist; Bulletin 8, page 16. Perth: By Authority.

WATER.

The field, as a whole, is well watered, and, generally speaking, fresh water can be obtained anywhere by sinking to a comparatively shallow depth, the only exception to this rule being in the immediate vicinity of the salt lakes, where the water is invariably salt; however, by sinking a mile or so away from these, fresh water is usually obtained.

TIMBER.

Timber is rapidly becoming a serious item on this field, mulga being the only kind available, both for mining purposes and for fuel, and is rapidly becoming exhausted, and in the more populous parts has to be brought in from considerable distances.

Description of the Individual Mining Centres.

The following is a description of the salient features in the different mining centres of Lake Austin, Tuckanarra, Quinns, Gabanintha, and Star of the East, Nannine, Meekatharra, Abbotts, and the Wilgie Mia, Weld Range. The descriptions are, for convenience, arranged in geographical order, beginning with Lake Austin on the south and taking each centre northwards. In order to facilitate the correct understanding of the various descriptive portions of the report a geological map of each centre has been prepared and attached to this report. These maps are on a scale of 20 chains to an inch, and show as much detail as this scale will permit. They should prove of some general value.

The Island and Mainland, Lake Austin.

The Island.

GENERAL TOPOGRAPHY.

The Island consists of a series of low greenstone and quartzite ridges, rising abruptly to a height of about 100 feet from the salt flat known as Lake Austin. It is about three miles in length, and nearly a mile across at its widest point; its general trend is a little east of north and west of south. It is traversed by a series of parallel quartzite bars, the main lines of which run almost absolutely straight from end to end of it. These usually rise up above the greenstones as low, rough hills and ridges, and are from a few feet to as much as two chains in width, and dip at a steep angle to the westward. They run very true, and are very little faulted, differing in this respect from the otherwise similar quartzites of Boogardie.*

To the eastward of the Island the salt lake stretches unbroken for several miles, while on the west is a mixture of salt lake and low sand dunes extending for many miles, the sand dunes rising to a height of 10 to 20 feet, with narrow arms of salt lake running between them in all directions; a stretch of lake some half-a-mile in width separates the Island from the mainland at either end. The boundary of the lake, except along the eastern shore of the Island and the southern shore of the Mainland, is, on the whole, very indefinite, and it is generally surrounded by low sand dunes, among which narrow arms of the lake run in all directions.

THE GREENSTONES.

These consist principally of a coarse-grained typical diorite, as well as a slightly foliated rock, which is probably only an altered form of the above; this latter occurs only over one or two small areas, the prevailing type of rock being massive and very coarse-grained. Sections of several samples of these rocks show them to consist essentially of pale green hornblende and felspar in about equal proportions, the hornblende being in both large and small crystals and plates, while the felspar (plagioclase) for the most part is in small crystals and irregular grains; it is somewhat decomposed; a little secondary quartz is also present. The greenstones are for the most part very decomposed and weathered down to a depth of from 120 to 150 feet.

THE HÆMATITE-BEARING QUARTZITES.

These are the main feature of the district, and occur as bands from a few feet up to two chains in width, running parallel to each other on a general north-north-east and south-south-west bearing, with a steep dip to the westward. They consist of banded quartz and hæmatite with magnetite, and are exactly similar to those occurring in the Boogardie District, and in all cases are found to be highly magnetic; they appear to be merely highly altered bands of foliated greenstone, and in some places can be seen to tail out imperceptibly into the latter. They are older than the quartz veins of the district, as the latter are often found cutting through them, and invariably carry a slight trace of gold, but not sufficient to make them payable, and at a depth generally carry a considerable quantity of pyrites. Their appearance at a depth is exactly similar to that at the surface, except in one case where, in a small bar at the 250 feet level in the Island Eureka G.M., a considerable amount of the hæmatite of the bar appears to be dying out and its place taken by blue quartz; this, however, is only on the hanging wall edge of the bar, and if it was cut through it would probably be found to still maintain its surface characteristics.

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* Geological Survey, Bulletin 8, page 16. Perth: By Authority, 1903.

The following are two partial analyses made in the Departmental laboratory of samples of these quartzites taken from the north end of the Island:—

Geological Museum Number.	[5110]	[5109]
Iron, Fe	39·65 per cent.	42·11 per cent.
Silica, SiO_2	38·42 „	36·38 „
Phosphorus P	·068 „	·106 „
Sulphur S	·042 „	·054 „
Water (hygroscopic) H_2O ...	·12 „	·14 „
Water (combined) H_2O ...	4·03 „	2·49 „

The numbers [5110], [5109] refer to the numbers in the Museum Register.

The Reefs.

These almost invariably run parallel to and close alongside the quartzite bars, dipping in the same direction as the latter, which is nearly always towards the west, and generally consist of white quartz, being very irregular both in size and in their gold contents; they are always very broken and unsettled in the upper workings, but become more defined and regular in the harder country at the deeper levels. The quartz reefs appear to be of later origin than the quartzites, as in several cases they are found cutting through the latter; in such cases they are usually much richer at the point of intersection. The reefs which run alongside the quartzite bars are invariably found to carry the best gold when they are in actual contact with the bar; as soon as they are separated from it by even a few inches of country rock the stone begins to get appreciably poorer. Many of the quartz reefs in this district were phenomenally rich near the surface; the chutes, however, were small and extended for no distance, either longitudinally or vertically; at a depth a little below water level they always contain considerable amounts of pyrites.

A fair amount of alluvial gold was obtained here in the early days, but appears to be all worked out now, as nothing is being done in that line; the areas worked were small. Speaking of the alluvial workings, Mr. H. P. Woodward, late Government Geologist, says:—*

> The diggings on the Island were some of the richest and most concentrated on the field, and it is the only place where anything like deep ground was met with, a defined gutter being found on the bed rock at 15ft. from the surface. The alluvial ground ran down from a saddle near the centre of the Island in an easterly and westerly direction towards the lake, but no auriferous reefs have yet been found immediately on its course. The sinking was pretty tough in places, as the alluvium was cemented together by gypsum.

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* Report on the Murchison G.F. By H. P. Woodward, Government Geologist, page 13. Perth: By Authority, 1893.

WATER.

Water was met with in all the mines here at depths varying from 60 to 90 feet, its level being about twelve feet below the surface of the lake; it is present in very large amount, but is exceedingly salt, this being almost the only centre on the Murchison Goldfield where such is the case, and water for domestic purposes, as well as for cyaniding, has to be carted or pumped from wells several miles distant. The water from the mines is, however, being used for battery purposes, with very satisfactory results. Most of the water used on the Island for domestic purposes is brought by train from Cue; the principal mines, however, have wells situated some three miles to the south and a couple of miles inland from the edge of the lake. A good supply of fair water is obtained from these. At the Mainland salt water is also met with in a large quantity a few feet below the level of the lake bed; water for domestic purposes and for cyaniding is here being pumped from a well near Day Dawn; fair water has also been struck at a shallow depth in a well about a mile and a-half inland from the shore of the lake.

TIMBER.

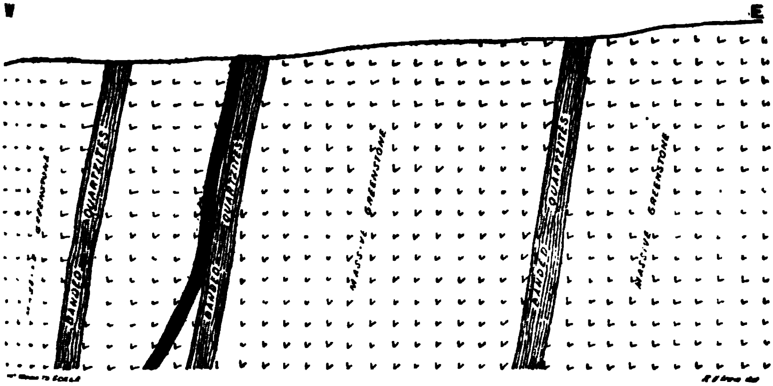
There is practically no timber in the neighbourhood, even of sufficient size for fuel, and both for this and for mining purposes it has to be brought in considerable distances either by train or wagons.

The Mines.

The following is a brief description of the principal mines in existence at the Island at the time of my visit:—

ISLAND EUREKA G.M. Co., LTD., 5D, 9D, 142D.—This Company is working a fair-sized quartz reef, which runs slightly east of north alongside a quartzite bar and dips with it at a fairly steep angle to the westward. In the upper levels the reef is right alongside the quartzite bar, but in the lower levels it gets off it and dips at a somewhat flatter angle. The reef is from four to seven feet in width, and consists of white quartz, with from six to 18 inches of schistose formation on the hanging wall, and has clean, well-defined walls. The richest stone is invariably found where the reef comes in actual contact with the quartzite bar, along the hanging wall of which it runs. A second large quartzite bar runs parallel to the reef, some 20 to 30 feet to the west of it; this bar is almost vertical, while the reef is dipping towards the west: assuming the reef to keep on its present course, a further supply of rich stone should be met with where they come in contact. (Fig. 1.) The quartzite bars, as far as tested on this property, have been found to carry a little gold, but not sufficient to pay working expenses. Both these and the quartz reefs are heavily mineralised below about 150 feet or 60 feet below water level. Some very rich pockets of stone have been taken out of the reef, especially from near the surface; a considerable amount of work has been done on it, the main shaft has been sunk to a vertical depth of 315 feet, and levels put in at 250 feet for about 420 feet north, at 175 feet for about the same distance north and 150 feet south, and at 125 feet for about 350 feet north and 200 feet south, and a considerable amount of stoping has been done from each level. Water was met with at about 90 feet, and is now being pumped from about 260 feet at the rate of some 1,500 gallons per hour; it is exceedingly salt, and unfit for use either in the boilers or for cyanide purposes; it is, however, being used with satisfactory results in the battery. The country consists of a somewhat foliated greenstone, soft and decomposed to about 150 feet, but very hard and settled below this level.

FIG. 1.



CROSS SECTION NEAR MAIN SHAFT SHEWING THE MODE OF OCCURRENCE OF THE ISLAND EUREKA REEF. MURCHISON G.F.

Up to the end of 1903 this mine, as shown by the following table, has crushed 13,238·40 tons of stone for a yield of 19,194·39ozs. of gold, being at the rate of 1·45oz. per ton, and worth £3 17s. 10½d. per oz.

ISLAND EUREKA G.M. Co., LTD., G.M.Ls. 5D, 9D, 142D.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
Previous to 1897 ...	17·00	1,047·00	61·59
1897	406·40	1,367·25	3·36
1898	549·00	894·50	1·63
1899	30·50	429·18	14·07
1900	810·50	1,630·41	2·01
1901	2,405·00	3,426·30	1·42
1902	4,700·00	6,154·57	1·31
1903	4,320·00	4,245·18	·98
Total ...	**13,238·40**	**19,194·39**	**1·45**

ISLAND EUREKA SOUTH G.M.L. 281D, ETC. (LATE C SHAMROCK).—The workings on this property are situated quartz reef which runs along the western side of a large qu bar, and dips with it at a flat angle to the westward. The from two to three feet in width, and is rather irregular; quartzite bar forms the footwall of the reef, and it is along th that the best stone is got.

The present main shaft is down about 150 feet, and a s amount of driving and stoping has been done at this level; water was struck at about 60 feet and is very abundant; it is being pumped from the lower levels at the rate of about 2, gallons per hour. A lot of work has been done on the reef d to water level by the original prospectors, and some phenomen rich patches of stone were taken out. A second parallel reef r through the property a few chains further west along the east side of a large parallel quartzite bar; so far, practically no work h been done upon it.

The following table shows that up to the end of 1903 the crushings from these leases (Chicago Shamrock), were 164·10 tons for 888·93oz., including 63·68oz. specimens, being at the rate of 5·42oz. per ton, and worth £3 18s. 10½d. per oz.

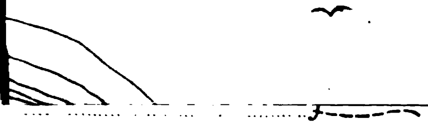
ISLAND EUREKA SOUTH G.M.Ls. 281D, ETC.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1897	5·10	343·15	67·28
1898	70·00	86·95	1·24
1900	58·00	† 427·83	7·38
1903	31·00	31·00	1·00
Total ...	164·10	888·93	5·42

† Includes 63·68oz. dollied and specimens.

GOLCONDA MINES, LTD., G.M.Ls. 35D, 42D, 68D, 69D, 70D, 74D, 79D, 143D.—Several lines of reef run through this property on a general bearing slightly east of north, and a large amount of work has been done upon them. At the time of my visit the mine was almost abandoned, and only a little work was being done in the upper levels; I was unable to examine the lower workings, owing to their being flooded. The main, or Golconda, reef is a large white quartz reef, running along the western side of a large quartzite bar, and dipping with it at a fairly steep angle to the west. This reef is in places as much as eight feet in width, but in the upper levels is very irregular. The best stone was obtained on the footwall, especially where the reef came in actual contact with the quartzite bar. As in most of the other mines in this district, some very rich pockets were found in the upper workings; these, however, were of

BULLETIN No. 14 PLATE II.



A. Gibb Maitland
Government Geologist.

R. H. Irwin del.
15/2.04.

H. J. Pether, Government Photolithographer. Perth. W. A.

UNIV. OF MICH.

very limited extent. In addition to the above reef, the Eureka lode also runs through the property. A shaft has been sunk to cut this near the Company's southern boundary, and a little work has been done upon it at a depth of about 180 feet.

Salt water was struck at about 90 feet, at which point the country begins to get hard and settled.

This mine, as may be seen by the table, has, up to the end of 1903, crushed 11,342·00 tons for 21,489·15oz., including 110·80oz. dollied and specimens, being at the rate of 1·89oz. per ton, and worth £3 17s. 6d. per oz.

The following tables, compiled from the latest official statistics, show the gold returns from the various other mines in the district up to the end of 1903:—

GOLCONDA MINES, LTD., G.M.Ls. 35D, 42D, 68D, 69D, 70D, 74D, 79D. 143D.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
Previous to 1897 ...	4,700·00	7,537·00	1·60
1897	1,335·00	3,244·25	2·43
1898	1,783·00	3,990·83	2·23
1899	2,787·00	4,961·16	1·78
1900	170·00	57·05	·33
1902	330·00	311·75	·94
1903	237·00	*1,387·11	5·85
Total ...	**11,342·00**	**21,489·15**	**1·89**

* Includes 110·80oz. dollied and specimens, and 7·00oz. alluvial.

The Mainland.

The Mainland exactly resembles the Island in its general configuration, rising on the south abruptly out of the salt lake and on the north and north-west from the alluvial flats which cover the greater part of the country between Lake Austin and Cue. It consists of a series of low, rough greenstone and quartzite ridges, whose general trend is about east-north-east and west-south-west, narrowed to a point at a spot about a mile and a-half north-east of the most northern extremity of the Island and then widening out gradually as it proceeds easterly, the edge of the lake maintaining a general easterly direction. The country rock is exactly the same as at the Island, consisting of a coarse-grained typical diorite very decomposed and broken down to a depth of about 100 feet. The only difference between the two places is that the quartzites at the Mainland have a more easterly and westerly strike, and are more faulted than those of the Island. In one or two places these lines of faults have been worked apparently in the hope of finding rich chutes such as are found under similar conditions at Boogardie.[*] The quartz reefs here, for the most part, run alongside the quartzite bars, and, as at the Island, are richest where in actual contact with them.

At the time of my visit very little work was being done at either the Island or the Mainland; in fact, at the latter place absolutely no work at all was going on, the only mine in existence —the Mainland Consols—being then under extended exemption. At the Island work was being carried on at the Island Eureka, Island Eureka South, and to a small extent on the Golconda.

One or two alluvial miners were also at work on the Island, but very little gold is obtained from this source.

The Mines.

The following is a brief description of the principal mines in xistence at the Mainland at the time of my visit.

Mainland Consols G.M.Ls., 6D, 60D, 61D.—At the time of my visit this property was under exemption, and I was unable to examine the lower workings owing to their being flooded. A large amount of work of a rather irregular nature appears to have been done, especially in the upper levels. Two lines of reef have been worked; one, the main line, being an approximately north-east and south-west reef running alongside a large quartzite bar and dipping to the north-west; the other, a smaller reef running at right angles to the former and dipping at a flat angle towards the north-east. This reef is from one to three feet wide where seen in the upper levels; the chute of gold was only some 50 feet in length and has been completely worked out, some very rich stone having been obtained near the surface in the early days.

The main reef is very irregular, both in size and in its gold contents, varying from one to eight feet in width. It runs alongside and to the north-west of a large quartzite bar which runs on a bearing of about 60 deg. and dips steeply to the north-west.

The reef has been followed for a considerable distance into the adjoining leases on the north-east and a large amount of work has been done upon it. The greater part of the stone is of low grade, but very rich pockets occur here and there. These pockets are always small, but are phenomenally rich and are generally found in contact with the main quartzite bar. The quartzite bars themselves, which run roughly parallel to each other, invariably carry a slight trace of gold, but are of too low grade to pay to work; both they and the quartz reefs carry considerable quantities of pyrites below water level. Water was met with at about 60 feet, and is very plentiful and extremely salt. The country rock is a coarse-grained diorite, considerably decomposed to a depth of about 120 feet.

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[*] Geological Survey, Bulletin 8, p. 16. Perth: By Authority, 1903.

This property, as may be seen by the table, has, up to the end of 1903, crushed 6,589·15 tons for a yield of 21,833·47oz., being at the rate of 3·31oz. per ton.

Mainland Consols G.M.Ls., 6D, 60D, 61D.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
Previous to 1897 ...	1,873·00	14,612·00	10·64
1897	1,726·15	3,124·62	1·81
1898	70·00	304·00	4·34
1899	700·00	311·00	·44
1900	1,607·00	2,024·55	1·26
1901	372·00	405·50	1·09
1903	741·00	1,051·80	1·42
Total ...	**6,589·15**	**21,833·47**	**3·31**

Minor Gold Returns from the Island and the Mainland to end of 1903.

The Island.

Name of Lease.	No. of Lease.	Ore milled. tons.	Gold yield. ozs.	Average oz. per ton.
Island Lake Austin G.M. Co. ...	8D, 40D	1,807·00	633·41	·35
Island Lake Austin South G.M. Co.	106D	20·00	2·00	·10
New Orient	155D	763·50	3,441·83	4·50
Von Moltke	11D	...	* 33·00	...
			† 61·91	...
Sundry claims	...	...	* 9·00	...
Sundry parcels treated at Island Lake Austin battery	...	119·00	53·00	·44
Totals	...	**2,709·50**	**4,234·15**	**1·56**

* Alluvial. † Dollied and specimens.

THE MAINLAND.

NAME OF LEASE.	No. of Lease.	Ore Milled. tons.	Gold Yield. ozs.
Comet	313D	22·00	* 310·00
Ingot	204D	30·00	† 101·65
Mainland East	97D	20·00	69·78
Mainland Eureka (late Mainland Consols Extended North, 147D)	161D (147D)	85·00	‡ 1,115·44
Perseverance	171D (85D)	119·70	§ 737·60
Wild Cat	135D	163·55	‖ 1,124·65
Total	...	440·25	¶ 3,459·12

* Includes 238·00ozs. dollied and specimens.
† „ 34·50 „ „
‡ „ 837·19 „ „
§ „ 405·55 „ „
‖ „ 274·65 „ „
¶ „ 1,789·89 „ „

TOTAL YIELD FROM DISTRICT.

	No. of Lease.	Ore Milled. tons.	Gold Yield. ozs.
The Island...	...	27,454·00	*45,806·62
The Mainland	...	7,029·40	†25,292·59
Total	...	34,483·40	71,099·21

* Includes 49·00ozs. alluvial, and 236·39ozs. dollied and specimens.
† „ 1,789·89ozs. dollied and specimens.

Tuckanarra.

This centre is situated about 26 miles slightly east of north Cue townsite, and just outside the southern boundary of Nannine District.

GENERAL TOPOGRAPHY.

The greater part of the country in the neighbourhood Tuckanarra consists of level plains covered with recent deposi through which rise occasional low ridges of greenstone travers by, and owing their origin to, numerous parallel bands hæmatite-bearing quartzites. These ridges seldom rise more th 60 or 70 feet above the surrounding plain.

Three or four miles to the east of the townsite the ridg become higher and more numerous, and continue thus for abo four miles, when their place is taken by an undulating belt of granit

country running about north and south. About two miles to the north-east of the townsite are a few small outcrops of granite, evidently part of a large body extending northward from this point and hidden by the superficial deposits which cover this part of the country to a considerable depth.

THE GREENSTONES.

The greenstones, within which the quartz reefs and the hæmatite-bearing quartzites occur, are the staple formation of the district; the main mass of granite to the north-east has evidently been intruded into them, and they are also intersected by several north and south granitic dykes which are apparently offshoots from the main body. They are for the most part massive, but are very much weathered and decomposed near the surface, and comprise diorites, quartz-diorites, and amphibolites. Of two specimens microscopically examined, the first [5316], taken from a spot 30 chains west of Boyd's Reward G.M.L., is a fine-grained, greenish rock, showing slight signs of foliation; a section (460) of it, seen under the microscope, shows it to consist of—

(*a*.) Hornblende, forming almost the entire section and being in small and irregular crystals and fibrous aggregates; it is a pale green variety showing strong pleochroism.

(*b*.) Felspar, occurring for the most part in small, clear grains, but a few small, lath-shaped crystals also occur throughout the section. A little ilmenite is also present in small scattered grains, and is in part altered into colourless to pale brown leucoxene.

A second specimen [5317], taken from 30 chains south-west of the same lease, is a coarse-grained, dark green, massive rock, with no signs of foliation; a section (461) of this, seen under the microscope, shows it to consist essentially of hornblende and felspar, together with a little quartz and some ilmenite.

The hornblende occurs principally in the form of large plates and irregularly formed crystals, and is considerably chloritised in parts.

Felspar is fairly abundant, and is probably principally oligoclase; it is considerably clouded from the presence of alteration products. Ilmenite is plentiful, both as grains and partially formed crystals; in a few cases it is altered into leucoxene.

Quartz is present, in small quantity, in the form of irregular grains and blebs.

THE QUARTZITES.

Traversing the greenstones are numerous parallel bands of hæmatite-bearing quartzites. North of the railway line these run in a general north-north-easterly direction, but south of it they take a sudden turn to the east, and run on a bearing varying from south-east and north-west to almost due east and west. These quartzites are similar to those occurring at Boogardie, which have already been described in the geological report* on that district as—

> Old fault lines or joints along which the original greenstones have been highly foliated parallel to the line of faulting, and thus formed zones of weakness along which thermal solutions containing iron, silica, etc., have forced their way to the surface, and gradually converted the original foliated greenstones into their present form.

They here run in narrow parallel belts, occasionally passing imperceptibly into foliated greenstone, from two or three feet to as much as a chain or two in width, and from one to five chains apart, and can be followed on the surface for a considerable distance. They are fairly regular in their course, but are crossed by numerous faults which, as a rule, throw them slightly to the west.

These lines of fault if properly prospected would, no doubt, be found to yield rich chutes of stone similar to those found at Boogardie.*

As far as tested, these bars have been found to carry a small amount of gold, but in no case have they proved rich enough to pay for working. They vary considerably in their appearance, in some the hæmatite and quartz being in fairly wide, well-defined bands, while in others, the banding is hardly visible in a hand specimen; they also vary greatly in the percentage of iron present in them, though in no case is this exceptionally high.

A partial analysis, made in the Departmental laboratory, of two typical samples, gave results as follows:—

	[5324.]	[5327.]	
Metallic iron ...	40·55 ...	38·15	per cent.
Silica	36·64 ...	38·54	„
Phosphorus ...	·02 ...	·20	„
Sulphur	·02 ...	·03	„
Hygroscopic water	·07 ...	·17	„
Combined water ...	4·13 ...	3·75	„

[5327] is from a spot on the telegraph line 8¼ miles north-east from Tuckanarra.

[5324] is from about two chains north of locality of [5327].

THE GRANITES.

Intersecting the greenstones in the northern portion of the field are several large granitic dykes. These run in a general north and south direction, and are apparently offshoots from the main body farther north, and vary in appearance from a fine-grained felsite to a coarse granite; a section (462) of a specimen [5318] of this latter type, taken from a large dyke about five chains east of G.M.L. 146, seen under the microscope shows it to be a holocrystalline rock consisting of—

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* Geological Survey, Bulletin 8, page 16. Perth: By Authority, 1903.

(*a.*) Quartz: very abundant, in large irregular lumps and grains almost entirely devoid of crystalline boundaries.

(*b.*) Felspar: also very abundant, and consisting principally of orthoclase and oligoclase; it occurs for the most part in irregular lumps with few signs of crystalline boundaries; a little of it is micrographically intergrown with the quartz.

(*c.*) Muscovite: fairly plentiful throughout the section in the form of colourless ragged flakes.

(*d.*) Magnetite: occurs as small scattered grains associated with the muscovite.

About two miles to the north-east of the townsite are a few small outcrops of what is apparently a large body of granite extending northward from this point to the neighbourhood of Munarra Gully; the greater part of this belt is covered by a considerable thickness of recent deposits, but where found outcropping it is seen to be a coarse-grained variety exactly similar in appearance to that outcropping near G.M.L. 146, and a description of a section which is given above. The junction between this granite and the greenstones is for the most part hidden by the recent deposits, but it appears that the granite is newer than and intrusive into the greenstones.

Some seven or eight miles to the east of the town is another large body of granite; this belt runs approximately north and south, and is of a similar type to the above.

SUPERFICIAL DEPOSITS.

Covering the greater part of the district is a considerable thickness of recent deposits; these vary in depth from a few inches to many feet, and are derived from the gradual denudation of the older rocks, and consist for the most part of a loose, red, somewhat sandy soil.

In addition to these deposits there are a few small areas of ironstone gravel; these occur as the cappings of greenstone ridges, but are of very poor quality and of very limited extent; they are found principally in the neighbourhood of the Bachelor G.M., and beyond the eastern extension of the map.

THE REEFS.

The majority of the reefs being worked in this district are those found occurring in connection with the quartzites. They are generally of white quartz, often sugary near the surface, and vary greatly both in size and in their gold contents, a reef often ranging from a mere thread to as much as 10 feet and more in the same workings. They usually run close alongside the quartzite bars, and at the points where they come in actual contact with the latter generally carry rich chutes of gold. These chutes, though often exceedingly rich, are small and very irregular in their occurrence, and the bulk of the stone between them is, as a rule, very low grade. These quartz reefs are of later formation than the quartzites, and are often found cutting across them; in such cases rich chutes of gold are usually obtained at the points of intersection.

Several reefs are being worked which occur in the greenstones at some distance from the quartzites. These are, as a rule, somewhat smaller, but are much more regular and more defined than the preceding type; their gold contents too are more uniform, and, on the whole, they are a much more promising class of reef.

A considerable amount of alluvial gold has been obtained from a spot about half-a-mile to the north of the townsite. This "patch" was about half-a-mile in length and from five to ten chains in width, and is situated on the side of a ridge along which a number of quartzite bars outcrop. The gold has probably been derived from a number of small quartz leaders and stringers associated with these bars, and was all found at a depth of only a few inches from the surface. At the present time this patch appears to be pretty well worked out.

WATER.

This district is well watered, and abundance of good fresh water is obtainable by sinking to a depth of about 80 feet.

TIMBER.

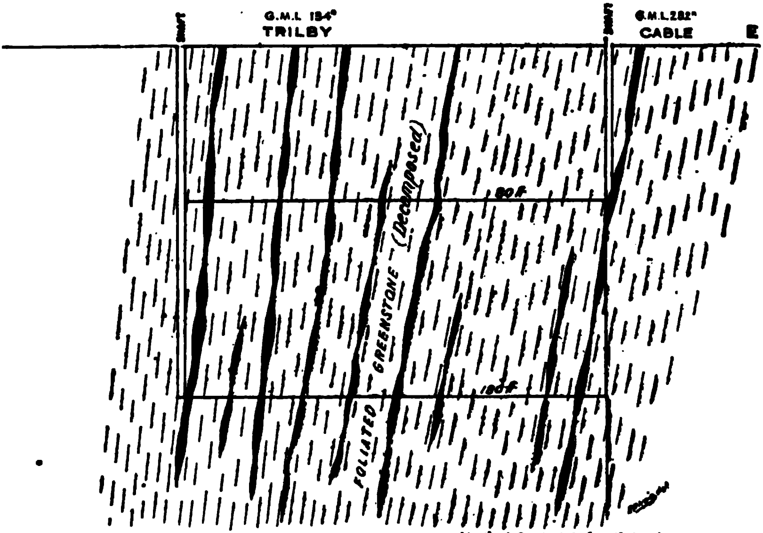
The only timber available for mining purposes and for fuel is mulga, and this is rapidly becoming very scarce in the near neighbourhood of the town, and most of the timber used has to be carted in from considerable distances.

The Mines.

The following is a brief description of the principal mines working in the district at the time of my visit:—

TRILBY G.M.L. 1132.—A good deal of work has been done on this property, though very little was going on at the time of my visit. The main shaft has been sunk vertically to a depth of 200 feet, and levels have been put in along the reef at 80 and 180 feet southerly to the south boundary of the lease, and northerly for a distance of 400 feet; a good deal of stoping has been done from these levels, all the stone above water being taken out, and crosscuts have been put in easterly for about 200 feet at oth levels with the purpose of cutting parallel reefs; not much ork, however, has been done on these. (Fig. 2.)

Fig. 2.



Horizontal Scale 2½ Chains to 1 inch
Vertical Scale 100 feet to 1 inch

CROSS SECTION OF REEFS AT TRILBY MAIN SHAFT. TUCKANARRA.

The main line of reef, which can be followed through this and the adjoining leases for some distance, is somewhat irregular in size, varying from one to six feet, and dips steeply to the westward, striking about north-north-west and south-south-east. Several smaller reefs run alongside the main one and further to the eastward, but as far as tested were very irregular both in size and in their gold contents, and, generally speaking, were very poor below water. Several shafts have been sunk to water on one of these eastern reefs, but very little work has been done from them, and they are now practically abandoned.

The country is a fine-grained greenstone, very soft and decomposed down as far as worked, and intersected by several small diorite (?) dykes, which run east and west and cut through the reefs without displacing them in any way.

An abundant supply of fresh water was struck at about 90 feet.

Blue Anchor G.M.Ls. 1190, etc.—This property adjoins the Trilby immediately on the north, the workings being situated on the same line of reef. Several shafts have been sunk, the deepest to a vertical depth of 150 feet. From this shaft drives have been put in southerly along the reef at 70 and 150 feet, that at the 70-feet level for a distance of about 600 feet, and the whole of the reef for this length stoped out to the surface; that at the 150 feet has been put in 400 feet, and this block stoped out up to the 70-feet level. Very little work has been done to the north of the main shaft. The reef, as was the case in the Trilby, is very irregular both in size and in its gold contents, varying from a few inches to as much as 10 feet, the large bunches being, as a rule, very low grade; in the upper workings it is running very nearly vertically, but at water level it is dipping at a steep angle to the westward; near the main shaft it is crossed by a small granite dyke running east and west, and dipping at a very flat angle to the south; this dyke, however, does not displace it in any way.

The country is greenstone, and is very decomposed and rotten as far as opened up.

Abundance of fresh water was struck at 75 feet.

At the time of my visit (October, 1903) no work was being done on this property.

ANCHOR CONSOLIDATED G.M., LTD., G.M.Ls. 1182, 1190, 1197, 1203, 1205.

—	Tons of ore treated.	Ozs. of gold therefrom.	Average ozs. per ton.
Previous to 1897 ...	...	...	...
1897	29·50	26·55	·90
1898	...	...	...
1899	254·00	297·00	1·17
1900	710·00	812·50	1·14
1901	3,837·00	3,028·37	·78
1902	2,201·00	1,934·40	·88
1903	40·00	* 80·25	...
Total ...	**7,071·50**	**6,179·07**	**·87**

* Includes 75ozs. by cyanide.

TRILBY No. 1 G.M.L. 1196.—This block adjoins the Trilby immediately on the south, and the workings are on the same lines of reef as have been worked on that property. Four shafts have been sunk to water level (90 feet) near the north boundary of the lease, and the three most westerly connected by a crosscut at this level. Two reefs were driven on southerly at water level for a distance of about 50 feet; these varied in size from six inches to two feet, but were very low grade, and no further work was done on them.

TRILBY No. 1 G.M.L. 1196.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1901	7·50	1·40	·19
1902	21·00	1·50	·07
1903	20·00	7·85	·39
Total ...	**48·50**	**10·75**	**·22**

Cable G.M.L. 1199.—Near the eastern boundary of this lease a large irregular quartz reef is being worked, varying in size from three to 12 feet, and consisting of a sugary ironstained quartz. Its general trend is about north and south, but near the main shaft it takes a sharp turn to the eastward for about 100 feet, and then gradually comes round to its north course again; it dips at a steep angle to the westward. The chute of gold is about 250 feet in length, and dips to the southward, but the values of the reef vary considerably within this length. The country is very broken and decomposed down as far as worked.

The main shaft has been sunk on the reef to a depth of 100 feet (water level), and drives put in along it at this level for 100 feet southerly and 160 feet northerly; very little stoping has been done. The reef is about 12 feet wide at the end of the south drive, but is much smaller and more broken at the north end. Near the western boundary a reef parallel to the Trilby line has been worked to a depth of 80 feet. This reef is from one to eight feet in width, averaging about three feet, and dips westerly, dipping into the Trilby lease at about 80 feet. It has been worked out from this level to the surface for a distance of 110 feet south, and 60 feet north in the Cable. Crosscuts have also been put into it from the Trilby main shaft at the 80 feet and 180 feet levels, and a little work was done on it at this latter level, but the stone had become very poor, and it was soon abandoned.

Cable G.M.L. 1199.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1900	65·50	73·53	1·12
1901	111·00	108·10	·97
1902	405·10	321·29	·79
1903	1,312·00	802·27	·61
Total ...	**1,893·60**	**1,305·19**	**·69**

Open Cut G.M.L. 1218.—The same reef is being worked on this property as on the Cable. It is here running north and south, and an open cut has been made on it to a depth of about 40 feet. A vertical shaft has also been sunk on it to a depth of 95 feet, and a drive put in southerly for 100 feet along it at this level, and a little stoping done. The reef, which dips west at an angle of about 80°, as seen in the drive, is very irregular and broken, varying in size from three to 12 feet. Its gold contents, too, vary greatly, the stone as a whole being low grade, with occasional small rich patches.

A crosscut has been put in easterly from the shaft at the bottom level, for a distance of about 60 feet, with the object of cutting a second parallel reef which outcrops about a chain to the east.

TRILBY, BLOCK I, G.M.L. 1218 (OPEN CUT).

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1900	104·50	74·65	·71
1901	28·00	5·40	·19
1902	...	...	...
1903	...	...	...
Total ...	**132·50**	**80·05**	**·60**

LADY EVA G.M.L. 1180.—This property is situated about two miles east of Tuckanarra township. A large white quartz reef runs through about the centre of the lease on the western side of a large felsite dyke running north-west and south-east. It has no defined course, but twists about in all directions. Three shafts have been sunk on it, the deepest being down 70 feet, and the other two 40 and 20 feet. About 60 feet of driving has been done from the 70 feet shaft, but no stoping. The reef, as opened up here, is from four to six feet wide. The greater part of the stone is of very low grade, but a few rich pockets were obtained, principally along the junction of the reef with the dyke. At the time of my visit a little work of a prospecting nature was being carried on near the surface.

The country is greenstone, considerably foliated, and getting very hard almost at the surface.

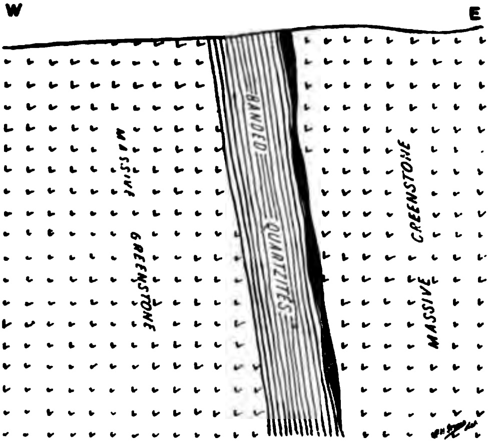
LADY EVA G.M.L. 1180 (109N).

Year.	Gold.
1897	70·85oz. dollied and specimens.
1898	19·90 oz. ,, ,,
Total	**90·75 oz.** ,, ,,

BOYD'S REWARD, R.C. 64N.—A fair-sized quartz reef runs along the eastern side of a large quartzite bar running about north-west and south-east near the western boundary of this lease. This reef, which varies in size from six inches to three feet, and dips with the bar (Fig. 3) at a steep angle to the eastward, has been worked down to a depth of about 90 feet. Several shafts have been sunk on it to this depth, and a block 200 feet in length has been stoped out from this level to within about 30 feet of the surface.

A main vertical shaft has been sunk to a depth of 200 feet a little to the east, and crosscuts put in to intersect the reef at 140 and 180 feet, but no further work has been done from it, and at the time of my visit the workings were full of water.

Fig. 3



SECTION SHEWING THE MODE OF OCCURRENCE OF REEF ON BOYDS REWARD G.M L 64 TUCKANARRA.

The reef is very patchy, the gold occurring in small, short chutes, or pockets, some of which were phenomenally rich.

The country, as far as worked, consists of very soft, decomposed greenstone.

A plentiful supply of fresh water was struck at about 95 feet.

Boyd's Reward, R.Cs. 341, 342 (R.C. 64n):

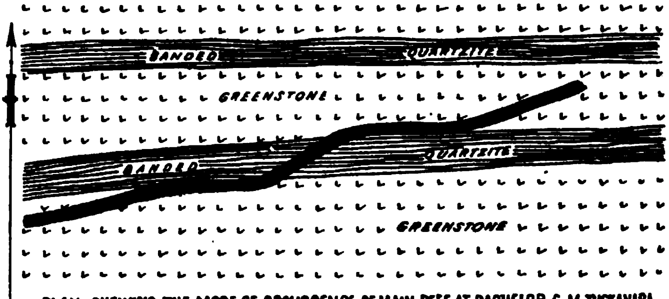
Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1899	210·50	3,245·44	15·41
1900	345·00	*697·30	2·02
1901	156·00	242·30	1·55
1902	33·00	377·65	11·44
1903	91·00	178·45	1·96
Total	835·50	4,741·14	5·67

* Includes 34·65oz. dollied and specimens.

Nemesis G.M.L. 1337 (late **Bachelor**).—This property is situated about six miles to the east of Tuckanarra townsite.

Several quartzite bars run through the lease on a bearing slightly north of east and south of west. A small irregular quartz reef and several small quartz leaders run alongside and across one of these bars. This reef has been worked to a depth of 100 feet by means of two vertical shafts, from the most western of which drives have been put in along the reef for 150 feet east and 80 feet west at both the 50 and 90 feet, but practically no stoping has been done. The reef varies in thickness from a few inches to about three feet, and is very irregular in its gold contents; a very rich chute was obtained at the point where it crosses the quartzite bar (Fig. 4) and has been worked out from water level (100 feet) to the surface.

FIG. 4.



PLAN SHEWING THE MODE OF OCCURRENCE OF MAIN REEF AT BACHELOR G.M. TUCKANARA

Several other parallel reefs run through the property, and, doubtless, similar rich chutes will be found in these at their points of intersection with the quartzites.

The quartzites carry a fair percentage of pyrites below water level as well as a small amount of gold.

Several other leases have been pegged out along this line of reef, but, so far, practically no work has been done upon them.

The country is greenstone, very soft as far as opened up.

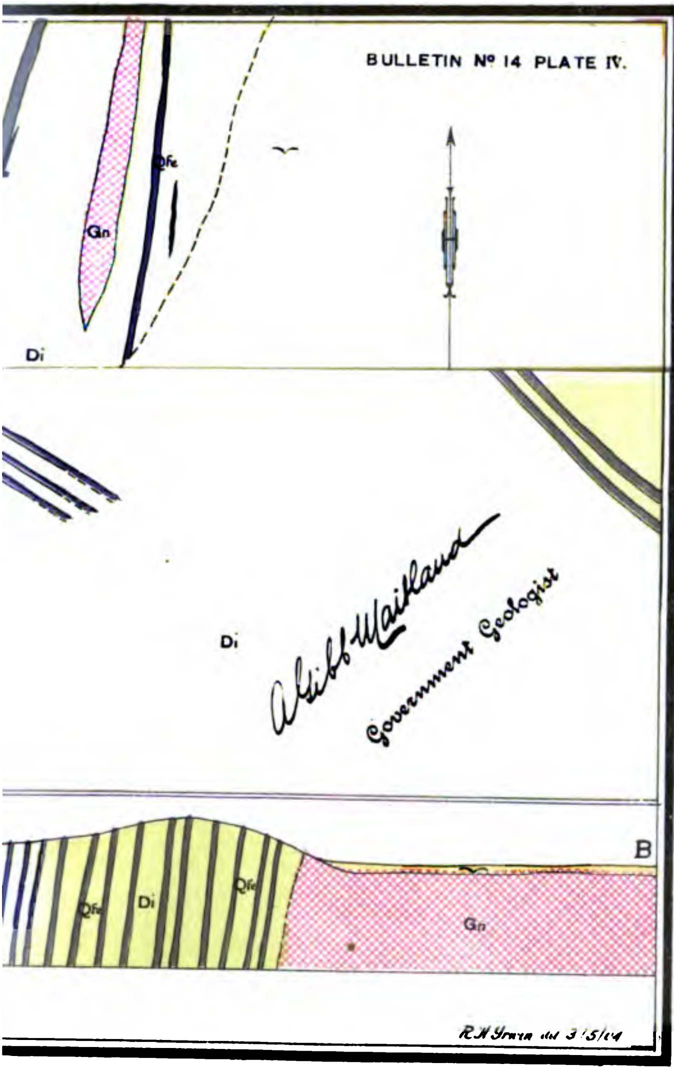
Good fresh water is met with at 100 feet.

NEMESIS G.M.L. 1337 (late BACHELOR G.M.L. 1192)

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1900	34·00	*143·10	4·21
1901	38·00	100·45	2·64
1902	58·00	70·75	1·22
1903	236·00	775·03	3·28
Total ...	**366·00**	**1,089·33**	**2·98**

Includes 24·65 oz. dollied and specimens.

BULLETIN No 14 PLATE IV.



A Gibb Maitland
Government Geologist

R.H. Green del 3/5/04

H. J. Pether. Government Photolithographer. Perth, W.A.

UNIV OF MICH.

The following table shows the total gold returns from the leases at Tuckanarra, other than those already mentioned, up to the end of 1903:—

Name of Lease.	No. of Lease.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
Bright Smile	1396	23·00	10·50	·46
Diorite Queen	1225	39·00	22·30	·57
Douglas Boulder	1280 (199N)	187·50	*629·67	4·51
Dyke	1242	83·50	18·80	·22
East Lynne	1223 (131N)	27·00	10·14	·39
Federal	1349	119·00	14·60	·12
General Gordon	1285	10·00	34·00	3·40
Just-in-time	1378	15·00	3·65	·24
Maybelle	1363	181·00	41·20	·23
Newhaven	1200 (287N)	57·00	†165·09	2·89
No. 1 South Tuckanarra	1191 (223N)	160·00	50·00	·31
Rand	1226	10·00	62·50	6·25
Tuckanarra North	1185 (206N)	143·00	40·10	·28
(W. Dowson)	P.A. 599	24·00	14·70	·61
Sundry Claims	...	313·15	70·57	·22
Treated at Public Battery	...	...	‡589·40	...

* Includes 465·12oz. dollied and specimens.
† „ 118·95oz. „ „
‡ By cyanide.

The Country between Tuckanarra and Munarra Gully.

From Tuckanarra northwards the country is greenstone, traversed by hæmatite-bearing quartzites, to a point about a mile north of the Trilby G.M., where granite makes its appearance, continuing mostly as level plains covered with loose sandy soil, with bare outcrops of rock here and there, to a spot about a mile south of Munarra Gully, where it once more disappears below the greenstones. The northern boundary of this granite belt runs easterly nearly as far as Stake Well, and westerly for eight or ten miles, then turning away north. The country in the neighbourhood of Munarra Gully is hilly, and consists of massive fine and coarse-grained greenstone. The belt is some 15 miles across, and runs in a general northerly direction from this point. Its eastern extension includes Stake Well, at which point the greenstones are traversed by a series of north and south belts of hæmatite-bearing quartzites, similar to those occurring at Tuckanarra, Nannine, Boogardie, and other places on the Murchison goldfield. These belts run in an almost due north and south direction, and have been proved to extend northerly for at least 10 miles. Stake Well is about their southern limit.

After Many Years G.M.Ls. 23CN, 231N, etc.—These leases are situated at Munarra Gully, about nine miles north of Tuckanarra; a large quartz reef runs east and west through them, and a good deal of work has been done on it down to a depth of 300 feet on the underlay (90 feet vertical). The reef, which is rather bunchy, runs up to 10 and 12 feet in width, averaging about six feet, and dips at an angle of from 30° to 40° to the north; it carries a large percentage of pyrites at water level and a considerable quantity of oxide of iron, resulting from the oxidation of the pyrites, above water level. A good deal of copper is also associated with it; this, which is mostly in the form of malachite (green carbonate), occurs usually in bunches, some of which were very rich. A little sulphide ore is beginning to make its appearance at water level, at which depth the reef is lying much flatter than at the surface. At a point some five chains west of the main shaft the reef takes an "S" curve for a few chains and then runs on again on its original bearing; at this point a vertical shaft has been put down to a depth of 75 feet, and a little driving and stoping done from it. Eastward from the main shaft the reef is very poor, and practically no work has been done on it in this direction. The best stone was obtained near the surface from a large open cut about a chain west of the main shaft. In this shaft the reef pinches out at a point about 100 feet from the surface (on the underlay), but makes again a few feet further down, and in the bottom level is from eight to ten feet in width, with clean, well-defined walls, and giving every promise of living to a much greater depth. The main shaft has been sunk on the underlay to a depth of about 320 feet (90 feet vertical) to water. Levels have been put in at 80 feet for a distance of 300 feet west and 50 feet east, and at 300 feet for 300 feet west; a little stoping has been done between the 80 feet level and the surface, but none at the bottom level. These workings were carried out by the original company, and are now abandoned, and the leases have recently been repegged by a new syndicate, who are erecting a five-head battery at the eastern end of the reef, and are carrying on work in a small way both at this point and at the extreme western end of the reef, where an underlay shaft has been sunk to a depth of about 40 feet, and a little driving and stoping done from it. The reef here is low grade and is very irregular, varying from a few inches to as much as four feet.

At the eastern end of the line what appears to be a parallel reef has been worked to a depth of about 40 feet, partly by the original company and partly by the present owners; a considerable quantity of fairly rich stone was taken out of a large open cut by the original owners, and a water shaft sunk to a depth of about 60 feet. The present syndicate are now working this reef at a depth of about 40 feet; it is low grade—being expected to average about seven dwts.—and very irregular, varying from a mere thread to as much as six feet.

An abundant supply of good fresh water is obtained at about 90 feet vertical in the main workings and at about 50 feet on the lower country.

The country consists of massive fine and coarse-grained greenstone, and gets very hard and settled at about 75 feet.

AFTER MANY YEARS G.M.Ls. 230/1N, 265/6N, 314N, 322N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
1900	11,321·00	5,727·73	·50
1901	...	* 88·00	...
1902	168·00	175·80	1·04
1903	12·75	15·00	1·17
Total ...	**11,501·75**	**6,006·53**	**·53**

* By cyanide.

The Country between Munarra Gully and Quinns.

(Thirty-one miles E.)

The road from Munarra Gully to Quinns for the first mile runs south, over greenstone ridges, till it comes on to the granite country; it then turns easterly and runs over granite flats, close to their northern junction with the greenstones, to a spot a mile or two west of Stake Well, where the granite disappears and its place is taken by greenstone ridges traversed by north and south bands of hæmatite-bearing quartzites. The greenstones extend to within about half-a-mile of the railway line at Stake Well, when they give place to extensive flats covered with a considerable thickness of recent deposits, which apparently overlie greenstones, and heavily timbered with mulga, except in the near neighbourhood of Stake Well, where it has all been cut for firewood, etc. These flats continue uninterruptedly to Culculli, at which point there is an outcrop, in the form of a low ridge, of greenstones traversed by several small north and south quartzite bars; from here the flats continue again for a further distance of about three miles, at which point there is a large bare outcrop of granite extending for two or three miles, and apparently trending away north-east. From here the flats are continuous on past Burnakura—at which place there are a few low greenstone ridges—to a point about three miles west of Quinns, at which spot the country becomes hilly, and consists of massive greenstones traversed by several parallel quartzite bars, which run in the form of a rough semicircle round the Quinns townsite, and intersected by intrusive areas of granitic schists.

Quinns.

The mining centre of Quinns is situated about 35 miles to the east of Tuckanarra. Speaking of this district, Mr. Woodward, a former Government Geologist, says * :—

> At Quinns some low, rough ranges of metamorphic rock rise from the plain, which for a considerable distance from them is strewn with stones.

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* The Murchison Goldfield, by H. P. Woodward, page 20, Perth. By Authority, 1893.

The reefs here are mostly large and very ferruginous; in fact, in some cases would be better described as iron lodes. These, of course, though consisting of hæmatite at the surface, will make into pyrites in depth, which will be more troublesome to work; therefore only those reefs which are very rich will be worth working after they cease to pay the prospectors to do so by hand.

Some of the gullies in these hills proved very rich in alluvial gold, and were easily worked, as the gold was found in a defined gutter, but up to the present no reefs along these gullies have been found which were rich enough to work.

The Sir Garnet is a large lode, mostly composed of hæmatite, in which there are some bunches of quartz which show gold freely. This hæmatite is the result of the decomposition of sulphides, which will be met with in depth. Considering the richness of the stone, length of outcrop, and size of the lode, this mine should pay.

The Premier is also on a large ironstone lode, but seems to carry the gold only in small veins, on the extent of which will depend the value of this mine.

There are several other reefs being prospected, but on these very little can be said at present.

At Quinns there is a small area of granitic schists occurring entirely within the greenstones and from a mile to a mile and a-half in width and three miles or so in length, forming a series of low, rough ridges, rising to a height of 50 feet or 60 feet above the plain, and in about the centre of which the townsite of Quinns is situated. The rock itself, which appears to be a very highly foliated granite, is very much weathered and decomposed; a section (464) of a specimen [5333] taken from G.M.L. 467, seen under the microscope, shows it to consist of—

(*a.*) Quartz: abundant, in irregular grains and imperfectly formed crystals.

(*b.*) Felspar: also very abundant, in large irregular lumps and tabular crystals; it is probably principally oligoclase, but is very clouded and decomposed.

(*c.*) Biotite: fairly plentiful, in long, ragged flakes considerably altered and bleached.

Most of the present workings are situated in these schists, near their western end.

The schists are surrounded by greenstone ridges extending outwards for several miles, when they die out and give place to level plains covered with recent deposits. These greenstones are very much decomposed and weathered on the surface, and consist for the most part of a coarse-grained diorite, a section (463) of a specimen [5329] of which, taken from a point five chains north of G.M.L. 453, seen under the microscope shows it to consist of—

(*a.*) Hornblende: comprising about 50 per cent. of the section, and occurring in the form of small lath-shaped crystals and irregularly-shaped plates and grains; it is considerably chloritised in places.

(*b.*) Felspar: forming the greater part of the remainder of the section, and in the form of small grains and lumps, for the most part without any signs of crystalline boundaries; it is probably principally oligoclase, but is much clouded and considerably decomposed.

(*c.*) Magnetite: fairly plentiful in scattered grains throughout the section.

A few small crystals of apatite are also present, as well as a little calcite in irregular grains.

The rock is somewhat weathered, and shows slight signs of foliation; this, however, may only be the result of the weathering.

These greenstones are traversed by parallel bands of hæmatite-bearing quartzites of the usual type, which run, roughly, parallel to the junction of the greenstones with the schists, and form rough ridges 50 to 70 feet high. In one or two instances they have been worked for their gold contents, but not much work was done on them, and they have since been abandoned.

A partial analysis made in the Departmental Laboratory of a typical sample [5331] of these quartzites, taken from the Sir Garnet G.M.L. 23, gave results as follows:—

Metallic iron	29·63	per cent.
Silica	54·15	„
Phosphorus	·073	„
Sulphur	·034	„
Hygroscopic water	·08	,
Combined water	·60	„

THE REEFS.

These occur both in the greenstones and in the schists, most of those in the greenstones being found occurring in conjunction with the quartzites, although several large ones are found outcropping at some distance from them; these, however, are apparently no good, and no work has been done on them. At present all the workings in the greenstones have been abandoned, and the only reefs being worked are those occurring in the schists. These have a general trend about north-east and south-west, and though not large are very regular and well defined, with every promise of living to a considerable depth. The district is considerably handicapped owing to the fact that there is no battery nearer than Gabanintha—10 miles. A large amount of alluvial gold has been obtained from this field in past years, both over the greenstone country and the schists. Where found over the former, it appears to have been derived principally from numerous small quartz reefs and veins associated with the quartzites; while in the schists it is probably derived from small quartz leaders which run through them in all directions, and some of which are very rich.

Very little alluvial work is being done on the field at present.

WATER.

Fresh water is obtainable on the field at a depth of from 50 to 70 feet, and is apparently present in fair quantity.

TIMBER.

Timber (mulga) is still fairly plentiful throughout the district.

The Mines.

TWO JACKS REWARD LEASE 453N.—A fair-sized quartz reef runs on an approximately north-east and south-west bearing through this lease near its north-western boundary. The reef has a well-defined outcrop, and can be followed for a considerable distance through this lease and the adjoining one. On it two shafts have been sunk—the most westerly to water level (80 feet), and t easterly to a depth of 50 feet. From the former of these, dri have been put in 20 feet east and 30 feet west at water level, but stoping has been done. In this shaft the reef is six feet wide at t surface, 18 inches at 40 feet, and four feet at water level, and co sists of white laminated quartz. The second shaft is down 5 feet underlay on the reef, and a block about 25 feet in length has bee stoped out each way from this level to close to the surface. Th reef, as shown here, is about five feet wide in the west face and thre feet in the east, its average width throughout being about fou feet, and dips at an angle of about 80° to the south; the walls are very clean and well defined right from the surface.

The country consists of granitic schist, and is fairly soft as far as opened up.

Good fresh water was struck at a depth of about 80 feet.

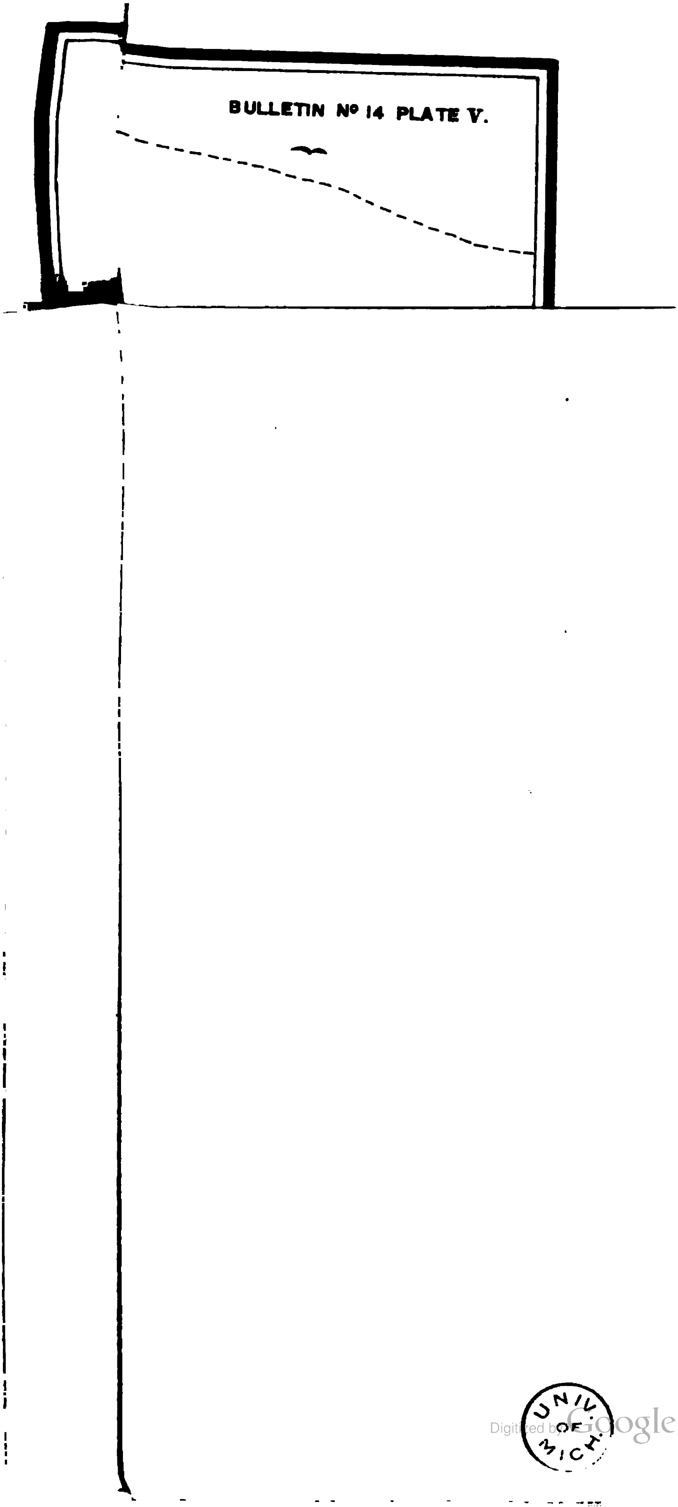
A second reef runs through the property nearly parallel to the main line, a couple of chains farther north. This is a fair-sized, nice-looking reef on the surface, but so far no work has been done on it.

Up to the end of 1903, 215·00 tons of stone had been crushed from this mine for a yield of 217·77ozs., including 22·02ozs. dollied and specimens, giving an average of ·99oz. per ton.

On the adjoining lease, on the west, a little work has been done on the same line of reef, which is here about six feet in width, and 10 tons of surface stone were crushed for an average yield of 10dwts.

CORNSTALK G.M.L. 465N.—The reef on this property runs about north-east and south-west; on it a shaft has been sunk to a depth of 35 feet, and a few tons of stone stoped out; an open cut has also been made on the reef a few chains south-west from the shaft to a depth of about 20 feet. The reef, which consists of clean, white laminated quartz, is about 12 inches in thickness at the top of the shaft, widening to about two feet at the bottom; in the open cut it is about three feet, and dips to the south-east at an angle of about 75°; the richest stone so far has all been found on the footwall side of it, that on the hanging wall being as a rule poor, especially where the reef widens. The country is granitic schist considerably decomposed and softened, but the walls of the reef are very clean and well defined right from the surface.

BULLETIN No 14 PLATE V.



UNIV. OF MICH.

During 1903 this property crushed 81·00 tons of stone for 62·15ozs. of gold, being at the rate of ·76oz. per ton.

Princess Dagmar G.M.L. 478N.—This lease adjoins the Cornstalk on the south-west, and is working on the same line of reef; a vertical shaft has been put down on it to a depth of 50 feet (water level), and about 30 feet of driving and a little stoping have been done at this level. As far as opened up, the reef is about three feet in thickness, and consists of clean, white laminated quartz, as in the Cornstalk; it dips at an angle of about 80° to the south-east. Good water was struck at 50 feet, at which level the reef is some four feet in width, and appears to be improving in value. The country is fairly soft granitic schist, and the walls of the reef, as in the Cornstalk, are clean and sharp right from the surface. To the end of 1903 this mine has crushed 58·50 tons for 42·10ozs., an average of ·72oz. per ton.

Homestake G.M.L. 467N.—Several lines of reef run through this property in the prevailing north-east and south-west direction. On the most northerly of them a fair amount of work appears to have been done, but it is now abandoned. On the reef at present being worked a couple of shafts have been put down to a depth of about 30 feet, but no driving or stoping has been done. The reef as exposed in these shafts is slightly bunchy, varying from 12 to 30 inches, and dips steeply to the south-east; it consists of clean, white laminated quartz, and has clean, well-defined walls. The country is granitic schist. So far, 25 tons of stone have been crushed for an average of 10dwts.

Yorkshire Lass G.M.L. 479N.—The workings on this lease are on the same reef as the Homestake workings. The only work done so far consists of an open cut from 10 to 15 feet deep, and some 40 feet in length; the reef, which has the same appearance as in the Homestake, is here from two to three feet in width, and dips to the south-east. The best stone is at present being got on the footwall side of the reef. During 1903, 17·50 tons of stone were crushed from this lease for a yield of 3·15ozs., an average of ·18oz. per ton.

The following table shows the total gold returns from the leases at Quinns, other than those already mentioned, up to the end of 1903:—

Name of Lease.	No. of Lease.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
Joe Chamberlain ...	469N	20·00	8·40	·42
Manchester	214N	...	* 17·37	...
Nowthanna	420N	567·00	† 517·55	·91
(Grant and Davis) ...	L.C. 49	...	* 164·15	...
Sundry claims	...	...	* 103·03	...

* Dollied and specimens. † Includes 17·25ozs. dollied and specimens.

The Country between Quinns, Gabanintha, and Nannine.

(Ten miles north, then 20 miles west.)

For the first mile or so out of Quinns, towards Gabanintha, the country consists of low greenstone ridges, which gradually die out and give place to extensive level plains covered with a varying thickness of recent deposits; these continue to Star of the East, where the greenstones again outcrop, continuing as low ridges on past Gabanintha, where they are intersected by several large areas of intrusive granite. About halfway between Star of the East and Gabanintha is a ridge of almost pure hæmatite and magnetite, running about north and south. This ridge is from one to two chains wide, and extends for several miles. It appears to be of similar origin to the hæmatite-bearing quartzites of Tuckanarra, Nannine, etc.

From Star of the East the plains continue right to Nannine, with the exception of one break at a spot about six miles from the former place, where there is a fairly large greenstone and quartzite ridge similar to those occurring at Nannine, running about north and south. At Nannine there are a series of greenstone and quartzite ridges of the prevailing type, extending in a general north and south direction; beyond these, to the westward, the granite again outcrops, and extends in that direction indefinitely.

Gabanintha and Star of the East.

The mining centre of Gabanintha is situated about ten miles to the north of Quinns and some twenty-one miles east of Nannine. In the neighbourhood of the townsite the country consists of low rough greenstone ridges, extending southerly and westerly for about three miles, when they give place to extensive flats covered with recent deposits. Northerly they extend for some miles, and easterly for about half-a-mile when they are replaced by level granite country extending easterly for two or three miles, when greenstone ridges again come in, extending for a further three or four miles, when they are once more replaced by a large belt of granite running about north and south.

Some two miles to the north-east of the townsite of Gabanintha is situated Mount Yagahong; this is an almost flat-topped hill rising to a height of some 300 feet above the surrounding plains, and having, on the southern side, vertical cliff faces for about one hundred feet from the top. It consists of horizontally bedded basic tuffs which are well seen in the cliff faces, where they appear as a fine grained rock closely resembling a slate in appearance, the rocks on the top of the hill being coarser grained. A section (473) of a specimen [5334] taken from a few feet from the top, and seen under the microscope, shows it to be a fragmental rock consisting principally of broken crystals of felspar (plagioclase) showing very few signs of alteration; in addition to the felspar there are numerous small crystals of colourless augite and minute flakes of pale green hornblende considerably chloritised; small crystals of magnetite are also present, and one or two inclusions of rock fragments as well as a considerable amount of colourless glass.

These tuffs overlie the granite. A few miles to the eastward are one or two other hills exactly similar in appearance to Mt. Yagahong; these also are probably composed of similar bedded tuffs.

THE GREENSTONES.

The greenstones, which are the staple formation at Gabanintha, are for the most part massive, showing only slight signs of foliation in one or two places, except close to their junction with the intrusive granite, where there is considerable local foliation; they are as a rule a fine grained variety, and consist of diorite, amphibolite, and more or less altered forms of the former. A section (465) of a specimen [**5336**] taken from the Sovereign G.M.L., seen under the microscope, shows it to be a fine-grained, slightly foliated rock, consisting of—

(*a*.) Felspar (plagioclase): occurring in imperfectly formed crystals and plates; it is probably principally labradorite, and is considerably clouded from the presence of decomposition products.

(*b*.) Hornblende: very abundant, in irregular flakes, grains, and crystals; it is principally a pale green variety, and appears in places to be an alteration product of colourless augite. A green chloritoid substance is also present, evidently an alteration product of aggregates of hornblende crystals. A few small scattered grains of magnetite also occur.

THE GRANITES.

Intruded into the greenstones are large masses and dykes of granite; the main mass of this starts about half-a-mile east of the townsite, and extends easterly for three or four miles, southerly for about a mile, and northerly indefinitely; numerous small dykes also intersect the greenstones in close proximity to this mass, especially on the eastern side, and are evidently offshoots from it. Another smaller intrusion of granite occurs about three-quarters of a mile to the south-east of Star of the East.

The greenstones are highly foliated near their junction with the granites, the foliation being always parallel to the junction line and extending over a width of from four to five chains.

The granite is always massive and entirely free from any schistose structure. The main body is a coarse-grained, somewhat pinkish variety, and in its mineral constitution approaches nearer to a granitite than a true granite.

A section (467) of a typical specimen [**5345**] of it, taken from a spot about 40 chains north-east of G.M.L. 32, shows it to consist essentially of quartz, felspar, and magnetite.

The quartz and felspar constitute about equal portions, occurring as irregular lumps and imperfectly formed crystals; there is also a little micrographic intergrowth of the two. The felspars, which are probably orthoclase, are considerably decomposed and clouded, and in parts much ironstained.

Magnetite is present in considerable quantity, and a good deal of it is in the form of skeleton crystals, which appear to result from the decomposition of biotite or hornblende.

A little secondary calcite is present, as well as a few small scattered crystals of apatite.

The whole rock is considerably decomposed and weathered.

A second specimen [5343], taken from a small outcrop on G.M.L. 241, about three-quarters of a mile south-east of Star of the East, is somewhat similar, but is redder in colour and not so weathered; a section (466) of this rock shows it to be a granitite (granophyre) consisting, like the preceding, essentially of quartz, felspar, and magnetite. In this case the section shows a micrographic intergrowth of the quartz and felspar (flesh-coloured orthoclase) and regular crystalline aggregates of felspar fibres, as well as large irregular grains and crystals of quartz and phenocrysts of plagioclase (oligoclase). The felspars throughout are somewhat clouded and weathered. Magnetite is also plentiful in grains and imperfectly formed crystals. A little epidote, resulting from the alteration of the felspars, is also present in addition to a few small indefinite greenish particles, which probably represent the remains of minute flakes of biotite.

THE IRON ORES.*

About half way between Gabanintha and Star of the East is a low ridge consisting of almost pure hæmatite and magnetite, and extending on a bearing slightly west of north and east of south for about two and a-half miles; the belt of iron ore which forms this ridge is from one to two chains in width, and rises in places to a height of 50 feet or 60 feet above the surrounding country; it appears to be of similar origin to the hæmatite-bearing quartzites occurring so commonly throughout the district. There is a huge amount of iron ore of first class quality in this deposit, but its geographical position renders it practically valueless.

The following is a partial analysis made in the Departmental laboratory of a sample [5344] of this ore taken from a spot 40 chains E.N.E. of G.M.L., 241 Star Extended :—

Metallic iron	52·14	per cent.
Silica	·20	„
Phosphorus	·008	„
Sulphur	*nil*	„
Titanic oxide	12·68	„
Hygroscopic water	·15	„
Combined water	1·15	„

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* See page 81.

THE REEFS AND LODES.

These occur both in the greenstones and in the granite, those found in the latter being usually close to its junction with the greenstones, and consisting generally of very large white barren-looking quartz reefs outcropping for a considerable distance. In only one instance has a reef in the granite country been worked, viz., on G.M.L. 385, where a large quartz reef close to the greenstones, and running parallel to the junction, has been worked apparently to a depth of about 70 feet; evidently, however, it had not proved much good, and at the time of my visit had been abandoned for some time.

Some very large reefs are also found in the greenstones close to their junction with the granite, notably one about a quarter of a mile east of the townsite, which outcrops for about three-quarters of a mile and in places is over a chain in width on the surface. A little work has been done on this reef, but without satisfactory results. Most of the reefs in the greenstones run on a general bearing slightly west of north and east of south, and can often be followed for a considerable distance, *e.g.*, the Tumbulgum line, which has been traced for over a mile; their dip is usually pretty steeply to the eastward. In two cases reefs with an east and west strike have been worked with fairly satisfactory results, viz., at the Star of the East G.M. and the old Mt. Yagahong mine, now the Archibald Q.C. 47.

Generally speaking, the reefs are very irregular and bunchy. This state of things, however, may improve with depth, as at present little or no work has been done below about 150 feet, except on the Star of the East Reef, which has been worked to a depth of 500 feet. A lot of copper is present in all the reefs at Gabanintha, especially at the Mountain View G.M. (Dyer's) and the Tumbulgum G.M., some very rich stone having been obtained from both these properties. So far, the ore has consisted principally of the carbonates malachite and azurite, but doubtless sulphide ore will be met with a little below water level, when the value of the ore will probably improve.

In two cases lodes have been worked simply for their copper contents, viz., at M.L. 1N, where several small lodes, running about north-west and south-east, have been worked to a depth of about 40ft., and at G.M.L. 340N, where a small irregular north and south lode was worked to a depth of 30 or 40ft. Both these properties were abandoned at the time of my visit, and I was unable to examine them in detail; very little work appears to have been done on them, and from what little I was able to see I am of opinion that they are not likely to develop into payable copper propositions, especially when their distance from the railway line and smelting works is taken into consideration.

A considerable quantity of chrysocolla (silicate of copper) is found associated with the ore on G.M.L. 340N; this occurs as blebs throughout the stone, some of them being of fair size. From its general appearance, this is locally thought to be turquoise, and was worked as such; the following analysis, however, made in the Departmental laboratory, of a picked sample [5338] obtained from the mine by myself, rather explodes this theory:—

Silica, SiO_2	39·90	per cent.
Copper oxide, CuO	43·36	,,
Ferrous oxide, FeO	·65	,,
Magnesia, MgO	Trace	
Alumina Al_2O_3	*Nil*	
Phosphorus pentoxide P_2O_5	*Nil*	
Water at 100° C. H_2O	9·36	,,
Water at a red heat, H_2O	7·42	,,
	100·69	,,

Asbestos, of an inferior quality, is found in small quantity on M.L. 1N, about three miles east of the townsite, occurring in small north and south veins in the greenstone.

WATER.

This locality is fairly well watered, water being met with in most of the mines at from 60 to 80 feet, and being of good quality; the supply, however, is at present limited, and further sinking and driving will be necessary before an adequate supply for the batteries will be obtained.

TIMBER.

Timber is fairly plentiful in this locality, but consists only of mulga.

The Mines.

The following is a brief description of the principal mines working in the district at the time of my visit:—

ARCHIBALD Q.C. 47.—This claim is on the reef formerly worked by the Mt. Yagahong Company.

The reef is a large irregular east and west one dipping to the north, very flat near the surface, but with a fairly steep inclination below 40 feet; it consists of white quartz considerably ironstained, and is very irregular in size, ranging from a few inches to as much as eight feet near the surface; it pinches out very small at water level and also at the west end; at the east end there is a large make of stone, but it is of very poor quality. The reef is very much broken and faulted, and twists about in all directions, maintaining, however, a general east and west bearing; it has been worked out for a length of 100 feet down to water level, principally by the original company; the present owners are now doing a little work at the 40 feet level, and also near the surface towards the eastern end of the reef.

The country is very soft and rotten down to the 80 feet level, at which depth a good supply of fresh water was struck.

No work has been done below water level.

MT. YAGAHONG G.M.L. 189N.

Year.	Tons of ore treated.	Ozs. of gold therefrom.	Average ozs. per ton.
Previous to 1897 ...	342·00	660·00	1·93
1897	1,056·00	945·60	·89
1898	663·00	786·75	1·18
1899	...	...	...
1903*	15·00	33·85	2·36
Total	**2,076·00**	**2,426·20**	**1·16**

* Registered as R.C. 47N (Wetherson & Bevan).

MOUNTAIN VIEW G.M.L., 379N.—Two reefs run through this property, one in a north and south direction and the other in a north-west and south-east, meeting near the main working shaft and then running northerly apparently as one reef. The work done on the property consists of a main working shaft, sunk near the junction of the two reefs to a vertical depth of 150 feet, from which drives have been put in along the reef for about 100 feet at the 80 feet and 150 feet levels. A little stoping has been done from the 80 feet level, but none from the 150 feet. A second shaft has also been sunk a little farther south to a depth of 40 feet, and a good deal of driving and stoping done at this level; these workings are, however, now abandoned.

The reefs consist of a mixture of quartz and highly foliated greenstone ranging in thickness from two to four feet, and are very irregular and broken. The quartz occurs for the most part in bunches, some of which are of considerable extent, while others only extend a few feet; these bunches are generally richer in their gold contents than the lode matter (foliated greenstone). Both the quartz and the lode matter carry a high percentage of blue and green carbonates of copper, the lode matter being in places particularly rich, some small pockets of ore being obtained averaging over 30 per cent. of copper.

The country consists of fine grained greenstone, and is commencing to get hard and settled in the bottom workings. Water level is 80 feet, the supply being fresh but limited in quantity.

MOUNTAIN VIEW G.M.L., 379N.

Year.	Tons of ore treated.	Ozs. of gold therefrom.	Average oz. per ton.
1901	43·00	33·20	·77
1902	54·00	52·20	·96
1903	366·00	337·95	·92
Total ...	**463·00**	**423·35**	**·91**

Golden Hope G.M.L. 461n, late Band of Hope.—A fai sized quartz reef runs through this property on a bearing nearl north-west and south-east. Near the southern boundary of th lease it is faulted and turned due east for about 100 feet, when i dies out completely. This eastern arm, which is very broken an irregular and dips at a flat angle to the north, has been worked ou to a depth of about 45 feet, at which point it gets very poor; som very rich stone was taken out of these workings, especially from close to the surface. The quartz in this part of the reef is ver much broken and ironstained, but is apparently perfectly free from copper. The main north-west extension of the reef runs on a ver perfectly straight course right through the lease, but is of low grade, and not much work has been done on it, though one or tw small patches of rich stone have been taken out. It dips fairly steeply to the eastward, and averages about four feet in width. though it is considerably more in places. A small very much ironstained quartz leader runs along the hanging wall of the main reef: this is generally very rich, but is too small to be of much use, though a small parcel of very rich stone was taken out of it near the north end of the lease.

Most of the work done on this property was done by a former company. The present owners are doing a little work on the south end of the reef, at the 40 feet level, on some stone left by the original company, and are also engaged in prospecting along the surface farther to the north.

Golden Hope G.M.L. 461n. (late Band of Hope G.M.L. 370n).

Year.	Tons of ore treated.	Oz. of gold therefrom.	Average oz. per ton.
1901	101·00	161·95	1·60
1902	23·00	23·00	1·00
1903	86·00	115·00	1·33
Total ...	**210·00**	**299·95**	**1·42**

Canterbury G.M.L. 443n (late Murchison Queen).—A large lode runs through this property in a north-west and south-easterly direction, having a steep dip to the south-west. It consists of a belt of highly-foliated greenstone, through which run small veins and strings of quartz; it has no defined limits, but has been proved to carry gold in varying amounts for a width of 28 feet. The gold occurs in it in small irregular chutes, usually where the quartz is most abundant; some very rich specimens were obtained at the 45 feet level. The main shaft has been sunk to a depth of 80 feet; at 20 feet a short drive has been put in northerly along the lode, but no stoping done; at 45 feet a second drive has been put in 60 feet in the same direction, and the lode stoped out for a width of 20 feet for 12 to 15 feet up; no work has been done below this. The country gets very hard at about 60 feet, consisting of a fine-grained, slightly-foliated greenstone. A plentiful supply of good fresh water was struck at 70 feet.

Canterbury G.M.L. 443N (late Unity G.M.L. 122N).

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
1897	58·00	28·00	·48
1898	49·00	46·24	·94
1899	...	...	...
1900	58·00	18·00	·31
1903	23·00	11·60	·50
Total ...	**188·00**	**103·84**	**·55**

Tumbulgum G.M.Ls. 32N, 46N.—A long line of reef runs in a general north and south direction through about the centre of these leases, and a lot of work has been done upon it down to a depth of 130 feet, mostly on the two northern leases. At present a little work is being carried on on the central block, principally at the 70 feet level. The reef right through the three leases is bunchy, and varies in thickness from three to eight feet; where being worked at present it is from three to four feet, being larger at the northern end; it runs nearly vertically, and consists of a belt of soft, highly-foliated greenstone with veins and bunches of quartz. These bunches, which are found on both the hanging and footwall of the reef, vary in thickness from a few inches to six or eight feet, and seldom extend for any great length, either longitudinally or vertically; they are invariably considerably richer than the lode stuff (foliated greenstone), which, as a rule, is rather low grade. Both the quartz and the lode stuff, right through the entire length of the reef, carry considerable quantities of carbonates of copper, and, in one or two instances, small pockets of very rich ore were obtained. In all cases the copper is present in sufficient quantity to pay for concentrating.

The country, as far as opened up, consists of soft, decomposed greenstone.

A good supply of fresh water was struck at 60 feet.

Nannine Goldfields Ltd. (Tumbulgum) G.M.Ls. 32N, 46N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1897	606·50	255·06	·42
1898	90·00	96·20	1·69
1899	37·00	53·80	1·45
1900	845·00	331·00	·39
1901	2,013·00	839·45	·41
1902	...	...	...
1903	697·00	565·60	·81
Total... ...	**4,288·50**	**2,141·11**	**·50**

Mt. Bungar G.M.L. 449n.—This property is situated four miles west of Gabanintha township; the workings a small quartz reef, which runs slightly north of east and so west, and is practically vertical; a shaft has been sunk on depth of 88 feet, and a drive put in westerly at this level fo 50 feet, and a little stoping done; a short drive has also be in westerly at the 30 feet level. The reef, as exposed workings, is from two to three feet wide, and consists of quartz, somewhat copper-stained in places; the walls are cle well defined, and consist of fairly hard schistose greenstone; feet to the east of the shaft the reef cuts out completely, a efforts have so far been made to pick it up again in this dire it should, however, from its appearance, live for a consid distance, both westerly and vertically.

The stone at present being taken out is expected to a about 30dwts.

Good water was struck at 88 feet.

A second large quartz reef outcrops two to three chains of the shaft, and runs about north-east and south-west. So f work has been done upon it.

Mt. Bungar G.M.L. 449n.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
1902	...	...	...
1903	121·00	80·30	·66
Total ...	**121·00**	**80·30**	**·66**

Star of the East G.M.Ls. 174n, 459n.—At the time of visit the main workings on this property were shut down, and was unable to examine them owing to their being full of wat The main shaft has been sunk to a depth of 500 feet, and levels p in at 150, 250, 350, and 500 feet; these have been continued e from the main shaft for a distance of 300 feet, very little wo having been done to the west. A block 300 feet in length has be stoped out from the 150 feet level to the surface. The reef in t lower levels is from four to six feet in thickness, while nearer t surface it is more irregular, varying from three to as much as feet. The chute of gold worked extended from the main sha easterly for a distance of about 300 feet; it cut out suddenly about 160 feet in depth, and could not be picked up again; the ston below this point carried a small amount of gold, but was too lo grade to pay. At the present time (November, 1903) prospectin is being carried on near the surface in the hopes of striking anothe chute.

UNIV. OF MICH.

Water was met with in large quantities below 150 feet; it was mewhat salt, but suitable for battery and cyanide purposes.

STAR OF THE EAST G.M.LS. 174N, 459N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
Previous to 1897 ...	9,888·00	11,575·00	1·17
1897	1,384·00	1,212·70	·87
1898	8,492·00	9,012·65	1·06
1899	2,220·00	1,721·10	·77
1900	3,434·00	2,173·84	·63
1901	1,013·00	1,803·36	1·78
1902	498·00	230·65	·46
1903	90·00	30·85	·34
Total	**27,019·00**	**27,760·15**	**1·02**

The following table shows the total gold returns from the ases at Gabanintha, other than those already mentioned, up to e end of 1903:—

Name of Lease.	No. of Lease.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
ella	316N	20·00	20·00	1·00
opper King	340N	14·50	1·85	·13
reetrade	409N (268N)	25·00	27·50	1·10
abanintha	237 (48N)	304·00	207·50	·68
apunda Gabanintha	255N	11·00	11·75	1·07
dy Maud	178N	60·00	130·00	2·16
artindale	31N	177·00	157·77	·89
yrmidon	268N	17·00	17·00	1·00
vereign	431N	137·00	90·85	·66
t. Albans	50N	301·00	431·40	1·43
t. Albans United	277N	55·50	62·35	1·12
undry claims	...	191·00	179·83	·94
undry parcels treated at Gore's (Canterbury) Battery	...	38·25	27·45	·71

Nannine.

The mining centre of Nannine is situated 50 miles north-east f Cue, and is the terminus of the railway line. The workings and ownsite are situated on the northern shore of Lake Annean, on the outhern end of a range of greenstone and quartzite hills, which ise to a height of about 100 feet above the level of the lake, and run lightly west of north; the country to the east and west of this ange of hills consists of level plains covered for the most part with considerable thickness of recent deposits. To the south is the hallow salt marsh (dry) known as Lake Annean.

A good deal has been written about the geology of Nannine,* and the following is taken from Mr. H. P. Woodward's † report on the Murchison goldfield:—

> Lake Annean is only shown on the map as a small round clay pan, but in truth it extends for about seven miles south, consisting of a succession of sandy ridges and marshes, which are impassable after rain. The main line of reef runs north from the lake up the spur of a rough ironstone ridge. It stands up in huge blows in places, and would, to anyone used to goldmining in other parts of the world, present a very unpromising appearance. But in spite of the fact that gold rarely occurs near these great blows, patches were found along this reef of great richness, and from holes a few feet in depth small fortunes were taken.
>
> On sinking these rich patches were lost, as the chutes dip to the north at such a slight angle, when it was thought that the reef would prove to be barren in depth, but fortunately the sinking was continued to water level, when the next rich chute from the south was struck, and in driving at this level to the north-west the first chutes worked were again found. These rich chutes in the main line dip north at an angle of about 30°, following the intersection, for the most part, of the ferruginous jaspery beds; besides these chutes of rich stone, the heavy bunches of rich stone and the breaks in the reef all follow the same dip, as well as the striations on the walls.
>
> The rocks are mostly schistose, with hard bands of ferruginous jaspery quartzite; these strike north and south, dipping at a high angle to the eastward, whilst the reefs strike a little east of north, and dip a little to the west where they do not go down vertically.

The range of hills, at the southern extremity of which Nannine is situated, consists of a series of roughly parallel greenstone ridges traversed by parallel bands of hæmatite-bearing quartzites, and trending in a general north-westerly direction. These ridges are from half to three-quarters of a mile in width, and gradually give place on the eastern side to level plains extending easterly, southerly, and northerly for many miles, and covered with a considerable thickness of recent deposits; on the western side, close to the foot of the ridges, the greenstones are replaced by massive granite, which appears to be intrusive, and which runs about north-west. After extending westerly for about a mile as fairly level country, the granite in turn disappears beneath the recent deposits of the plains, which then extend westward indefinitely.

THE GREENSTONES.

The greenstones are for the most part massive, showing only slight foliation over small areas, and consist of diorites, amphibolites, pyroxenites, and altered forms of the latter. A specimen [**5350**] of the latter variety, taken from G.M.L. 17N, is a fine-grained, slightly-foliated dark green rock, a section of which (470) seen under the microscope shows it to consist essentially of hornblende, augite, and felspar.

> The hornblende forms the greater part of the section, and is in irregular grains and masses; it is mostly a pale green variety, and is considerably chloritised in parts.

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* *Vide* page 12.

† The Murchison Goldfield by H. P. Woodward, page 17. Perth: By Authority, 1893.

Augite is abundant in colourless to pale brown crystals and grains, and is usually surrounded by the hornblende.

Felspar is fairly common throughout the section, and is in small grains and imperfectly-formed crystals; it is probably principally oligoclase, but is very clouded from the presence of decomposition products.

The hornblende appears to be an alteration product of the augite, which apparently originally formed the main constituent of the rock.

The greenstones are crossed by numerous diorite (?) dykes; these are not distinguishable from the surrounding rocks on the surface, and are only recognisable when met with in the workings below ground, where they are often found cutting across the reefs without, however, displacing them in any way.

THE QUARTZITES.

The hæmatite-bearing quartzites which traverse the greenstones are of the usual type, and run in parallel belts from a few feet to as much as two chains in width, having a general trend ranging from north-north-west to north-west, and have, in one or two instances at the south end of the field, been worked for their gold contents, but apparently without satisfactory results, as they have now been abandoned for some time past. They are slightly more siliceous here than is usually the case, and are very little faulted, running in very regular lines for considerable distances. The following is a partial analysis, made in the departmental laboratory, of a specimen [5352] taken from a spot 30 chains south of G.M.L. 249, Queen of the Lake:—

Metallic iron	31·28	per cent.
Silica...	47·48	„
Phosphorus	·312	„
Sulphur	·030	„
Hygroscopic water...	·28	„
Combined water	3·89	„

THE GRANITES.

The granite is a coarse-grained hornblende variety, and is considerably weathered; its general trend is between north and north-west; how far it extends in this direction is not known, but it runs southerly for from eight to 10 miles. A section (469) of a specimen [5349] taken from G.M.L. 115 shows it to be a coarse-grained holocrystalline rock, consisting essentially of:—

(*a.*) Quartz: occurring plentifully in irregular lumps and and grains.

(*b.*) Felspar: principally orthoclase, together with a little plagioclase and some microcline; it is in large plates and imperfectly formed crystals, and is for the most part considerably decomposed and altered with the formation of small flakes of colourless mica.

(*c.*) Hornblende: abundant, in large flakes and lumps and of a brownish green variety considerably decomposed. A few crystals of pale brown augite also occur associated with the hornblende, and in addition to these a few minute crystals of apatite are present.

Another specimen [5351], taken from the dump on G.M.L. 13 (Champion), though differing slightly in its macroscopic properties, when seen under the microscope is practically identical with the preceding, except that the felspars exhibit greater clouding and alteration, and augite is more plentiful; a few scattered grains of magnetite also occur throughout the section, and in addition there are present numerous small crystals of sphene.

One or two dykes of felsite also cut through the greenstones, one large one, occurring about a mile to the north-east of the town, being traceable across country for fully a mile.

THE REEFS AND LODES.

Quartz reefs are found both in the greenstones and in the granite, and are usually large and well defined. Most of those in the granite have a trend slightly east of north, and dip to the westward; while those in the greenstones usually trend a little west of north, and also dip to the westward—generally at a fairly flat angle. In some cases the same reef is found running through both granite and greenstone. One of these is the "Nannine," one of the largest in the district, and which outcrops for a distance of over a mile. For the greater part of its length this reef is in the greenstones, but near its southern end it runs into the granite, still maintaining the same bearing, and apparently the same dip. Another is the reef running through the Burgundy and Old New Year leases, which in the former is in greenstone, and in the latter in granite. Most of the reefs in the granite appear to have been of low grade, and are now all abandoned.

Two classes of quartz reefs are found in the greenstones, the first being associated with the hæmatite-bearing quartzites, and the second occurring at some distance from them, and usually close to the junction of the greenstones and the granite. The former vary greatly in size, but are always very irregular, and the gold in them is patchy, short rich chutes being obtained at the points where they intersect or come in actual contact with the quartzites, while the bulk of the reef is blank or, at best, low grade. Several reefs of this nature have been worked at the southern end of the field, but are now abandoned.

The reefs occurring near the junction of the greenstones and granite are usually large and well defined, and outcrop for considerable distances; their gold contents, also, are more uniform, though occasionally small rich chutes are found in them, this being especially the case in the "Nannine" reef, which, at its northern end, cuts across several quartzite bars, rich chutes being obtained at the points of intersection.

A considerable quantity of alluvial gold has been obtained from this district, especially from "Bailey's Island," about a mile and a-half to the south of the townsite, and also on the eastern fall of the ridge to the east of the town; in all cases the gold has been found in close proximity to the quartzites and has probably been derived from small quartz reefs and leaders associated with these. Most of the rich patches appear to have been worked out, and very little is being done in this line at the present time.

WATER.

Water is fairly plentiful, and at a little distance from the edge of the lake it is fresh, and is reached at a depth of from 60 to 70 feet. Near the shore of the lake its level is only a few feet below the surface; the supply is unlimited, but it is of course exceedingly salt.

TIMBER.

Timber consists only of mulga, and is becoming very scarce.

At the time of my visit (November, 1903), mining operations were very quiet at Nannine, there being only three or four mines working, and these only in a small way; the Champion mine was practically shut down, but it was reported that it was shortly to start sinking and development work again; this should prove a good thing for the district, and this is the biggest and best equipped mine in the place, and though the reef is very low-grade just at present, there is no reason why it should not improve again at a little greater depth.

The Mines.

The following is a brief description of the principal mines working in the district at the time of my visit, as far as I was able to examine them:—

CHAMPION GOLD MINES, G.M.Ls. 11N, 17N, 13N, ETC.—I was unable to examine the deeper workings on these properties owing to their being full of water at the time of my visit; the only examination that could be made was at the 70-feet level, where there was very little to see owing to the fact that the greater part of the stone had been stoped out. The reef, which is in the greenstones near their junction with the granite, and which has been followed for a distance of nearly a mile, runs on a bearing about 30deg. west of north, and dips at a flat angle to the westward; it varies a good deal in size in the upper workings, being as much as 12 feet in width in some parts, while in others it is not more than two; in the lower levels it is said to be much more regular. It has been worked to a depth of 500 feet on the underlay, and a large amount of work done on it; at the south end, on the Caledonia lease, it is more broken and much smaller. A little to the north of the main underlay shaft a second reef comes in on a bearing almost due north and south; this reef, which is about two feet in width, has been followed on the surface for a distance of about 15 chains, but not much work has been done on it. The gold in the main reef is somewhat patchy and is said to be getting very poor at the lower levels. The stone above water is a clean, white, laminated quartz, very free from copper or other mineral.

CHAMPION REEF (NANNINE, W.A.) G.M. CO., LTD.
G.M.Ls. 10N, 11N, 17N (37N, 43N).

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1897	9,303·00	4,687·23	·50
1898	1,511·00	1,056·20	·69
1899	733·00	390·70	·53
1900	4,670·00	2,005·30	·43
1901	1,383·00	380·40	·27
1902	4,972·00	3,043·05	·61
1903	876·00	*3,162·75	...
Total	**23,448·00**	**14,725·63**	**·62**

* Includes 2,262·15ozs. by cyanide.

NANNINE GOLD MINES G.M.L., 16N, 25N, 166N.—A large white quartz reef runs through these properties, and the adjoining ones on a bearing slightly east of north and west of south, and can be followed in an almost perfectly straight line on the surface for a distance of over a mile. For the greater part of this distance it is in greenstone, but near its southern end it is in granite running close to the junction of the latter with the greenstones. It varies a great deal in size in some places, being as much as 20 feet in width, while in others it pinches down to two or three; towards its northern extremity it is small and very much broken and faulted. It has been worked at intervals along its entire length, but at the southern end is very low grade. The majority of the work done on it is on the Nannine and Royalist leases, where it has been worked to a depth of about 200 feet.

These leases are crossed by a series of quartzite bars which run in a north-west and south-easterly direction and dip at a steep angle to the eastward; these bars are cut by the reef, and at the points of intersection rich chutes of gold are usually found, while at a little distance from the bars the stone is, for the most part, of fairly low grade, though small rich chutes are found in it in irregular intervals. I was unable to go through the lower workings on these properties owing to their being flooded, and so was unable to examine the reef or the country below the 120ft. level. At this depth a drive has been put in along the reef for a total distance of about 400 feet, and a little stoping done here and there. The reef, as shown here, is very bunchy, ranging, as before stated, from two to nearly twenty feet.

The country at this depth is very soft and broken.

The reef appears to be much more regular in size to the south, but I was unable to examine it here owing to all the workings eing abandoned; it is crossed by several diorite (?) dykes, one ear the south boundary of the Nannine lease being about 120 feet n width and running almost due east and west for some distance, hich cut right through it without displacing it at all.

The water level is about 90 feet, and the supply is good.

NANNINE LEASES 16N, 25N, 166N.

Year.		Tons of Ore treated.	Ounces of Gold therefrom.	Average ozs. per ton.
Previous to 1897	...	2,420·00	5,193·00	2·14
1897	...	232·50	230·03	·98
1898	...	433·00	278·96	·64
1899	...	1,444·00	4,466·58	3·09
1900	...	915·03	*2,866·26	3·13
1901	...	32·00	1,364·26	42·63
1902	...	809·00	881·82	1·09
1903	...	1,475·60	1,833·31	1·23
Total	...	7,761·13	17,114·22	2·20

* Includes 22·50 ozs. dollied and specimens.

QUEEN OF THE LAKE G.M.L., 249N.—The main workings on this property are on a large irregular lode formation trending about north-east and south-west, and dipping at a fairly flat angle to the north-west; it appears to be simply a highly altered belt of greenstone, and has no defined limits. A good deal of work has been done on it to a depth of 200 feet, but at the time of my visit these workings were abandoned, and a little work was being done on the north end of a quartzite bar running through the lease near its eastern boundary. Several of these bars run through the property, and, as usual, rich chutes of gold were obtained at the intersection of the lode with them, and also at the intersection with them of a second quartz reef farther to the west.

MT. YAGAHONG G.M. AND EXPLORATIONS CO., LTD., G.M.L. 249N. (late QUEEN OF THE LAKE G.M.L.)

Year.		Tons of Ore treated.	Ounces of Gold therefrom.	Average ozs. per ton.
Previous to 1897	...	7,374·00	5,943·00	·80
1897	...	1,185·00	551·40	·46
1898	...	...	...	..
1899	...	1,060·00	437·90	·41
1900	...	90·00	85·00	·94
1901	...	1,258·00	794·80	·63
1902	...	189·50	166·65	·88
1903	...	56·00	48·10	·86
Total	...	11,212·50	8,026·85	·71

The following table shows the total gold returns from the at Nannine, other than those already mentioned, up to th of 1903:—

Name of Lease.	No. of Lease.	Tons of Ore treated.	Ozs. of Gold therefrom.
Anglo Westralian and General Exploration, Ltd.	54N, 55N	107·00	32·85
Barrett's Peak	320	36·00	7·45
Caledonian	273N (168N)	887·00	1,438·65
Caledonian Extended	8N	413·50	2,113·77
Commonwealth	342N (219N)	41·00	67·70
Daisy	457N	57·00	206·00
Dunaustral	429N (267N)	...	† 40oz.
Alberfoyle G.M., Ltd.	242N, 261N (267N)	93·00	*290·67
Esmeralda	102N	16·00	25·20
Golden Gate	463N	...	‡73·85oz.
Granite King	421N (330N)	108·00	143·45
Iron King and Kaiser Proprietary	73N, 113N	50·00	51·50
Lake Shore	240N	49·00	48·75
Mt. Yagahong Exploration Co., Ltd.	7N, 15N, etc.	13,944·00	11,541·91
New Caledonian	264N	136·00	223·55
New Year G.M., Ltd.	18N	717·50	590·40
Old New Year	438	111·00	80·35
Pearl	308N	80·00	34·20
Referendum	343N	41·00	50·00
Three Star	484	12·00	3·95
Wanganui G.M. Co., Ltd.	415N	1,922·00	675·10
(Graham and party)	P.A. 124	29·00	65·85
(Hughes and party)	P.A. 132	20·00	18·90
Sundry Claims	...	654·50	1,083·05
Sundry parcels treated at Queen of the Lake Battery	...	10·00	26·00
Nannine District generally ...	...	...	†3,087·70
Sundry parcels treated at Nannine Cyanide Works	...	...	202·76oz.

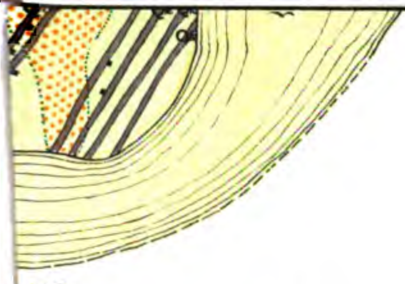
* Includes 62·85ozs. dollied and specimens.

† Alluvial.

‡ Dollied and specimens.

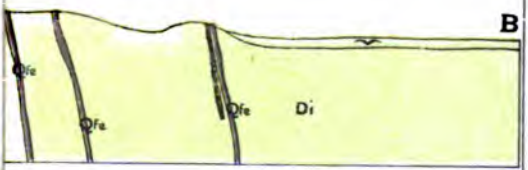
The Country between Nannine and Abbotts.

From Nannine the country passed over consists of extensive flats, covered with recent deposits which apparently overlie greenstones, and sparsely timbered with mulga. This class of country continues unbrokenly to Meekatharra, at which point there are a series of low greenstone and quartzite ridges, extending to a point about two miles north of the townsite, where granite again makes its appearance as a level sandy tableland, with bare outcrops of rock here and there. Near Garden Gully this once more gives place to the greenstones, which extend for several miles as low ridges, gradually dying out and giving place to level plains covered with recent beds of red sandy soil; these continue to within a few



A Gibb Maitland

Government Geologist



R. H. Irwin del. 4. 5. 04.

H. J. Pether, Government Photolithographer. Perth. W. A.

UNIV. OF MICH.

ıiles of Abbotts. Here the country becomes hilly, the hills being reenstone for the most part covered with a considerable thickness f ironstone conglomerate (laterite).

Meekatharra.

The mining centre of Meekatharra is situated about 24 miles lightly east of north of Nannine. As shown on the Mines Depart- ıent route map, it is some 10 miles out of position (to the west), eing shown as at Trig. Station K.6, on Meekatharra hill, whereas is at Luke's Trig., some 10 miles due east of this point, and on ıe main surveyed road from Nannine to Peak Hill.

The country in the immediate vicinity of Meekatharra townsite ›nsists of low, rough, greenstone ridges, extending southerly for ›out two miles, when they give place to extensive plains covered ith recent deposits; westerly for three miles; and northerly for ro, when they are replaced by a large belt of granite trending ›out north-east; easterly they extend indefinitely.

These greenstones are very much decomposed and weathered, much so that it was impossible to obtain a specimen for deter- ination, none of the mine workings being down below the zone of composition. Immediately to the east of the townsite is a wide lt of banded quartzite trending slightly east of north and forming low ridge, on the highest point of which Luke's Trig. is situated. t this spot the belt is about three chains in width, but thins out nsiderably as it runs south. It only continues a short distance rth of the trig., but can be followed southerly for a couple of les. At their northern end the quartzites are practically free ›m iron, and closely resemble those occurring at Lennonville,[*] ıilst at their southern end, where there are several parallel bands d where they are more irregular, they are of the usual hæmatite- ıring variety, but appear to be much more siliceous than is ıerally the case.

The granite which occurs to the north and west of the townsite a coarse-grained massive variety, extending northerly for five or . miles, and being for the most part covered with a considerable ckness of loose, sandy soil, with the rock occasionally outcropping low, bare ridges. Numerous dykes run out from this main body o the greenstones, which are considerably foliated in close ›ximity to them.

A section (472) of a specimen [5354] of this granite, taken from pot about a mile north of the Havelock G.M.L., seen under the croscope, shows it to be a very similar rock to that occurring at et[†], and consisting of—

(*a.*) Quartz: fairly abundant, in fair-sized grains and lumps, for the most part without crystalline boundaries.

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eological Survey, Bulletin 8, page 15. Perth: By Authority, 1903. † *Vide* page 14.

(*b.*) Felspar: plentiful in large plates and imperfectly formed crystals, and consisting principally of orthoclase, with some plagioclase and a little microcline. It is a good deal clouded from the presence of decomposition products.

(*c.*) Hornblende: of a greenish brown variety, and occurring in the form of irregular flakes and lumps.

(*d.*) Biotite: occurring in parallel intergrowth with the hornblende.

One or two small crystals of colourless augite are also present, as well as a little sphene, in fairly well-formed crystals, and a few scattered grains of magnetite.

A second large similar belt of granite occurs about 10 miles to the east of the townsite, trending about north and south. A few small deposits of ironstone gravel (laterite) occur on the greenstone ridges; these are usually of very limited extent, but are often of a very high grade; in one instance, viz., just north of the Democrat G.M.L. 425, a small deposit of this nature is highly magnetic.

The auriferous quartz reefs of the district trend generally a little to the east of north, and are for the most part large and appear to be fairly regular in their course; so far, however, no work has been done in the district below water level, and not a great deal above either, but as far as opened up the majority of the reefs are very promising, and though some of them are rather irregular in the soft country in the upper levels they should improve as they get into the harder and more settled country below water.

As a rule, too, the gold is fairly uniform right through the stone, and is not found occurring in short chutes as in many other centres on the Murchison Goldfield.

Mining operations were very brisk at the time of my visit, and altogether I am of opinion that this centre has a very good future before it.

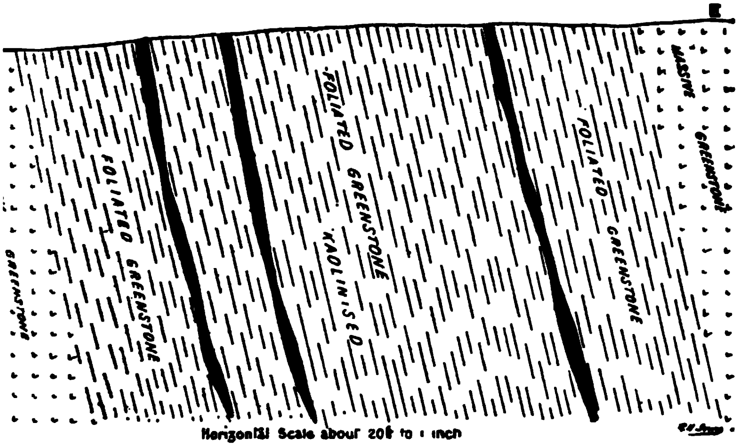
Fresh water is met with in the mines and wells at a depth of from 130 to 150 feet; the supply, however, appears to be somewhat limited, this being especially the case in the town wells, which frequently go nearly dry in the summer months; this might be remedied by further sinking and crosscutting. A new well for town supply purposes has just been put down four or five miles to the south-west of the townsite, and at present is giving a good supply of fresh water. Timber for mining purposes and for fuel is still fairly plentiful, but consists only of mulga.

The Mines.

The following is a brief description of the principal mines working in the district at the time of my visit (December, 1903):—

Havelock G.M.L. 236N.—Three or four parallel lines of reef run through this and the adjoining properties on a bearing slightly t of north and west of south, having a uniform dip of about 75° he east. On the most eastern of these several shafts have been k to a depth of 100 feet, and about 400 feet of driving put in g the reef at this level, and a good deal of stone taken out ween this and the surface. Considerable work has also been e on a couple of reefs farther west. The eastern reef, which is richest of the series, is from four to six feet in width, and con-s for the most part of white friable quartz, considerably broken associated with large quantities of kaolin; the other reefs, which some 20 feet farther west, are similar in appearance but smaller, g from two to three feet in width. The country between them sists of very soft kaolinised greenstone foliated parallel to the s of reef, and carries a little gold for its entire width. (Fig. 5.)

Fig. 5.



ROSS SECTION SHEWING THE MODE OF OCCURRENCE OF HAVELOCK REEFS NEAR MAIN SHAFT MEEKATHARRA

The reefs are crossed by several east and west faults, which dip the south and throw the reefs to the east for a distance of from to twelve feet; short rich chutes are generally found where these es of fault cross the reefs.

Havelock G.M.L. 236n.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1899	54·00	58·00	1·08
1900	136·00	188·70	1·38
1901	580·75	355·80	·61
1902	193·00	233·30	1·20
1903	711·50	504·65	·70
Total ...	1,675·25	1,340·45	·80

Havelock South G.M.L. 279n.—This lease adjoins the Havelock on the south. The workings are on one of the western lines of reef worked on the latter, and are down to a depth of 125 feet, at which level a good deal of driving and stoping has been done on the reef, which is more bunchy in this lease, varying from two and three feet up to as much as 20 in one place; its gold contents, too, are not as regular as in the Havelock. Several lines of fault cross the reef in an east and west direction, and dip fairly steeply to the south; they usually have a beneficial effect on the reef, which is generally richer in proximity to them; small quartz veins, up to three and four inches in width, are often found following these fault lines; they are usually very rich, and in one or two cases were large enough to pay to follow.

At the 100 feet level a crosscut has been put in easterly for a distance of 80 feet, prospecting for other parallel reefs, but without success. The country cut through consists of very soft kaolinised greenstone foliated parallel to the line of reef, and carries gold to the value of two or three dwts. per ton for the whole distance.

Havelock South G.M.L. 279n.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom	Average oz. per ton.
1901	188·00	191·05	1·01
1902	394·00	254·45	·65
1903	563·25	203·65	·36
Total	1,145·25	649·15	·56

Havelock North G.M.L. 257n (late Lone Hand 422n).—This block adjoins the Havelock on the north, and the workings are on the same line of reef; a good deal of work appears to have been done, but the old workings are all abandoned; a vertical shaft is now being sunk slightly to the east of the main line of reef and had just cut it at 100 feet. The only workings I was able to examine consisted of an underlay shaft down about 100 feet, from which about 200 feet of driving have been done, and also a little irregular stoping. Two lines of reef have been worked; the more eastern, on which most of the work has been done and which is apparently the same reef as is being worked in the Havelock, is from four to six feet in width, and very patchy; the stone is mixed with a large amount of kaolin, and is white and very friable; the gold occurs principally in short irregular chutes, though the reef carries a little gold throughout; the second reef, which is a little smaller, is about twenty feet to the west; not much work has been done upon it, as it was rather low grade where struck; it is similar in appearance to the eastern reef. The country between the two, as in the Havelock, carries a little gold right through. Both reefs dip at a fairly flat angle to the eastward. Several other shafts have been sunk on these reefs, but I was unable to examine any of them owing to their having been abandoned for some time past.

Near the north end of the lease the reefs cut out altogether, and the whole nature of the country changes; this is apparently brought about by a large fault which crosses the country here in an east and west direction; up to this point the country consists of a very soft white kaolinised greenstone foliated in a north and south direction—parallel to which the reefs run; beyond it the lines of foliation run east and west, and the country is much harder and not so altered.

So far, no signs of water have been met with in any of these three mines; this is owing to the fact of their being on much higher ground than any of the other mines in the district.

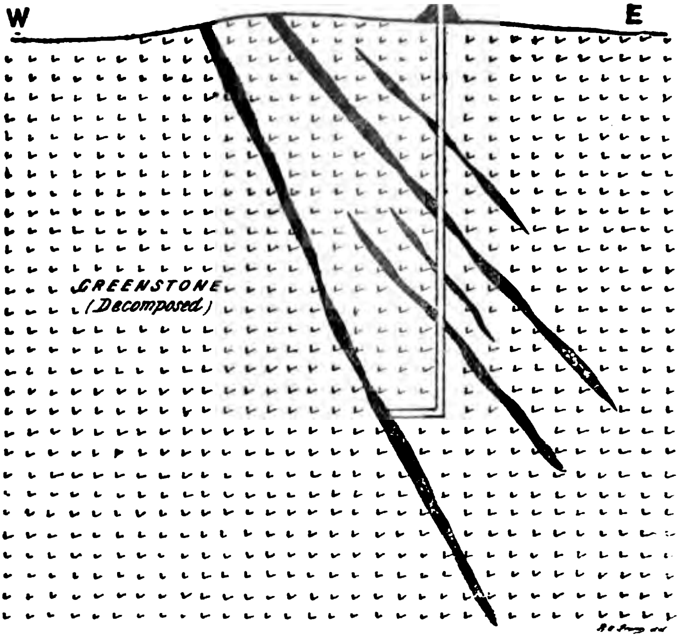
HAVELOCK NORTH (late LONE HAND G.M.L. 422N.)

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1901	203·00	73·95	·36
1902	300·50	149·45	·49
1903	104·00	25·10	·24
Total ...	**607·50**	**248·50**	**·40**

PIONEER G.M.L. 372N.—Several large quartz reefs run through this property on a bearing slightly east of north and west of south; on one of them a shaft has been sunk to a depth of 180 feet, and drives put in at the 100 and 180 feet levels, that at the 100 feet being 150 feet in total length, and that at the 180 feet about 30 feet longer; no stoping has so far been done from this latter level, but from the 100 feet a block 125 feet in length has been stoped out up to the surface. At the north end of the workings the reef, which dips steeply to the east, is about twelve feet in width, but in the south end it gradually cuts out altogether in the upper levels, but in the lower it is still going strong, with every likelihood of continuing for some distance; it is not uniform in size, ranging from two or three feet to as much as twelve. The footwall is very clean and regular, but the hanging wall is not so good. The reef is not being worked for its full width in the lower level, only a few feet of stone on the footwall side being taken out. The chute of gold being worked is about 100 feet in length, and dips to the south at a fairly flat angle in the upper levels, but steeply below.

The original reef worked is about a chain to the east of the one at present worked, and runs parallel to it, dipping in the same direction, but at a considerably flatter angle; it is smaller than the main reef, more irregular and not so good. Several other small reefs were cut in sinking the main shaft; these vary in size from a few inches to a couple of feet (Fig. 6), but were very poor where struck, and no work has been done upon any of them. The country, as far as opened up, is still very soft, consisting of a very much decomposed greenstone. Water was met with at 180 feet, and is fresh.

Fig. 6.



CROSS SECTION SHEWING THE MODE OF OCCURRENCE OF REEFS AT PIONEER MAIN SHAFT
MEEKATHARRA

Pioneer G.M.L. 372n. (late Meekatharra 90n).

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1898	61·00	47·35	·77
1899	...	...	...
1900	...	...	...
1901	283·00	251·70	·88
1902	888·75	996·05	1·12
1903	1,124·50	1,993·35	1·77
Total ...	**2,357·25**	**3,288·45**	**1·39**

St. George G.M.L. 323n.—The main line of reef on this lease runs through about the centre of it, on a bearing nearly north-east and south-west. On the surface it is a large white quartz reef, which outcrops for a distance of about 30 chains. Several shafts have been sunk on it, the deepest to a depth of 69 feet, at which level a drive has been put in along the reef for 140 feet and a little stoping done; the reef in this drive is about two feet in width, and dips to the east at a fairly flat angle; at present a crosscut is being put in at the 30 feet level to cut a large quartz reef about two chains to the west. This reef, which is the larger of the two, runs nearly parallel to the other at the north end, but a little south of the main shaft it turns and joins it, the two running south from this point as one reef. This reef also dips to the eastward at an angle of about 60 deg.; a little work has been done upon it at its junction with the eastern reef but it is at present too low grade to pay. A third reef, trending nearly east and west, runs into the main reef about three chains north of the working shaft; it is from 12 to 15 inches in thickness and dips deeply to the south. It is, however, too poor to be of any use.

St. George G.M.L. 323n.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1901	142·00	75·20	·53
1902	82·00	62·50	·76
1903	142·75	70·55	·49
Total	366·75	208·25	·56

Pioneer South G.M.L. 426n.—A large number of reefs run through this property in different directions, and a good deal of work has been done on them at different times. Near the south-western corner of the lease two small parallel reefs run on a north to north-westerly bearing; on the more northern of these a shaft has been put down to a depth of 150ft. and the reef stoped out for about 100ft. each way from the shaft from this level to within about 20ft. of the surface. This reef is from one to three feet in width and consists of clear glassy quartz; it dips at a fairly steep angle to the south-west. The gold in it was very patchy, some of the stone being very rich and some a few feet away scarcely carrying a trace.

The country is very soft white kaolinised greenstone. A little work has also been done on the more southerly of these two reefs, but they are at present both abandoned.

At the extreme north end of the lease a shaft has been sunk to a depth of 150 feet, and a little east and west crosscutting done with the intention of cutting the south continuation of the Pioneer reef. Only a few small leaders were cut in these workings, and the shaft appears to have been sunk right on a line of fault, which has thrown the reef some distance out of its original course. Several other shafts have also been sunk near the north end of the lease on a couple of large quartz reefs which outcrop there; these, however, proved to be very low grade, and they have since been abandoned.

The present workings are situated towards the south-eastern corner, where a shaft has been sunk to a depth of about 50 feet and a short drive put in at the 30 feet level on a small quartz leader running nearly north and south and dipping at an angle of about 45° to the east. This leader is from six to twelve inches in width and gives very good prospects; the quartz is white and glassy and very broken, and has associated with it in cavities considerable quantities of talc.

In sinking the shaft a large white sugary quartz reef was cut through. This reef runs north and south and dips very flat to the east; its exact width is not known, but it is at the least 20 feet; at the point where cut it was very poor, and no work was done on it; apparently it is the continuation of the large quartz reef worked in the Meekatharra South Block, the adjoining lease on the south.

The country is very soft and consists of white kaolinised greenstone.

PIONEER SOUTH G.M.L. 426N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1901	22·50	14·20	·63
1902	...	...	...
1903	47·00	49·18	1·04
Total ...	**69·50**	**63·38**	**·91**

MEEKATHARRA SOUTH BLOCK G.M.L. 93N.—The main workings on this property are situated on a large quartz reef running about north-east and south-west through the centre of the lease. The present workings consist of a large open cut worked to a depth of 75 feet and drives along the reef at this level. As shown in the open cut, the reef is about 40 feet in width and dips to the west at an angle of about 75 deg.; it consists principally of soft sugary quartz, with considerable quantity of talc in cavities, but in places becomes hard and glassy; it carries gold in small quantities for its full width, as well as containing numerous small, irregular pockets of rich stone. At the north end of the open cut, at the 75 feet level, the reef is lost and appears to have been cut off by an east and west fault dipping south at a very flat angle. It has been worked out for nearly its full width near the surface, but below about 30 feet only a strip along the footwall has been taken out and drives have been put in along and across the reef to test its values.

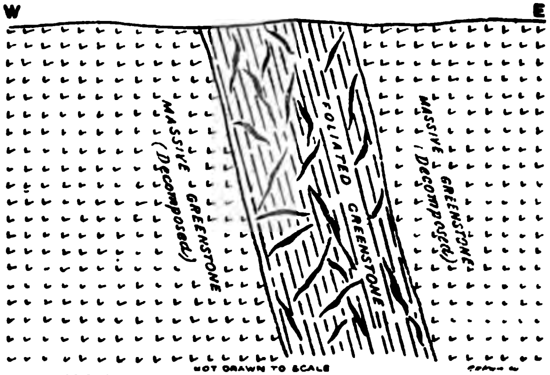
The original workings on the property are some four chains south of the present ones; here some very rich stone was found on the surface, and a shaft was sunk on the eastern side of the reef to a depth of 150 feet, and a crosscut was put in to cut it at this level; nothing was met with in this crosscut, and it appears as if it has been put in along, or close to, a line of fault, and not continued far enough to cut the reef, which appears to have been thrown to the west. Several other reefs outcrop at the southern end of the lease, but no work has been done upon any of them.

MEEKATHARRA SOUTH BLOCK G.M.L. 93N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1898	53·00	160·00	3·02
1899	72·00	130·25	1·80
1900	110·00	150·90	1·37
1901	753·00	561·10	·74
1902	580·00	344·50	·59
1903	593·50	189·45	·32
Total ...	**2,161·50**	**1,536·20**	**·71**

HALCYON G.M.L. 313N.—The main ore body on this lease consists of a large lode running slightly west of north to a point near the northern boundary, when it turns slightly and runs a little to the east of north. This lode consists of a belt of decomposed rock, through which small quartz leaders (Fig. 7) run in all directions, varying in size from a mere thread to several inches; at a depth it will probably turn into a belt of highly foliated greenstone, but, as far as opened up, both it and the

FIG. 7


W
E
MASSIVE (DECOMPOSED) GREENSTONE
FOLIATED GREENSTONE
MASSIVE (DECOMPOSED) GREENSTONE
NOT DRAWN TO SCALE

CROSS SECTION OF HALCYON LODE. MEEKATHARRA country are so decomposed and altered that it is almost impossible to tell where one ends and the other begins, except by noticing when the leaders cease, as these are only found within the lode; both the lode stuff and the leaders carry gold, some of the latter being extremely rich, whilst others are perfectly barren. On this lease, the lode has been proved to exist for a width of 16 feet, and appears to run almost vertically. The work done on it consists of an open cut 50 feet in depth and about the same in length and a shaft sunk to a depth of 100 feet; not much work has been done from this. The whole of the lode, as exposed in the open cut, is said to average about 10dwts.

The owners are at present engaged in working a series of fair-sized quartz leaders, running westerly into the main lode and dipping at a flat angle to the south; several of these leaders were cut within a few feet of each other in sinking an air shaft a couple of chains to the east of the main lode, and ranged in size from six inches to a couple of feet; one of them has been followed, at the 75 feet level, easterly from the main lode for about 90 feet, and a little stoping has been done on it; it is rather irregular and bunchy, varying from six inches to as much as three feet in places; its gold contents also vary considerably, parts of it being phenomenally rich, while parts, again, are very poor; taking it all through, it is expected to average about an ounce.

HALCYON G.M.L. 313N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
1900	23·00	* 56·45	2·41
1901	304·25	233·80	·76
1902	181·50	220·75	1·21
1903	462·25	190·70	·41
Total... ...	**971·00**	**701·70**	**·72**

* Includes 2·45ozs. of dollied and specimens.

DEMOCRAT G.M.L. 425N.—There are two sets of workings on this property. Those at the south end are on the northern continuation of the main lode worked on the Halcyon, which has here been worked down to a vertical depth of 150 feet. Down to the 120 feet level only the larger and richer of the quartz leaders were worked, and the workings are of a very irregular nature on account of this. Below 120 feet the lode has been taken out for its full width, but only for a short distance; it is here about 20 feet in width and dips steeply to the east, having the same characteristics as in the Halcyon.

The other workings are near the north-east corner of the lease, where a good deal of work appears to have been done on a similar class of ore-body running north and south.

Both these workings were abandoned at the time of my visit.

DEMOCRAT G.M.L. 425N (337N).

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
1902	142·00	127·80	·90
1903	423·50	116·70	·27
Total ...	**565·50**	**244·50**	**·43**

COMMODORE G.M.Ls. 283N, 284N.—At the south end of this lease a number of shafts have been sunk for the purpose of working a small quartz reef running north-east and south-west, and dipping to the westward. A good deal of work appears to have been done on it, and on a series of leaders running into it in all directions. These working were abandoned at the time of my visit, and I was unable to examine them. The main shaft is down 150 feet vertically to water level, the water being fresh.

At the north end the workings are on a fair-sized north-east and south-west quartz reef, which is probably an extension of that worked to the south; it is here as much as four feet in width in places, but frequently pinches to only a few inches. The hanging wall is very clean and sharp, but the footwall is not so good; it dips at a fairly flat angle to the westward. Several shafts have been sunk on it, the deepest being 120 feet on the underlay; drives have been put in from this shaft for a distance of 100 feet at both the 80 and 120 feet levels, but very little stoping has been done. The reef, on the whole, is low grade, though there were one or two small rich bunches on it. One or two smaller leaders come in from the east, and a little work has been done on one of them. A large lode formation runs east and west near the main underlay shaft; this formation is full of small quartz leaders, some of which are very rich, but the lode, as a whole, is too poor to work; its width has not been proved, but it is about 20 feet. Very little work has been done on it.

COMMODORE LEASES G.M.Ls. 283N, 284N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
1900	118·00	382·00	3·23
1901	297·25	1,113·80	3·74
1902	227·25	493·45	2·17
1903	613·50	385·30	·62
Total ...	**1,256·00**	**2,374·55**	**1·89**

INGLISTON G.M.L. 363N.—This lease adjoins the Commodore on the south; the workings are on the continuation of the Commodore's south reef, which is here about two feet in thickness.

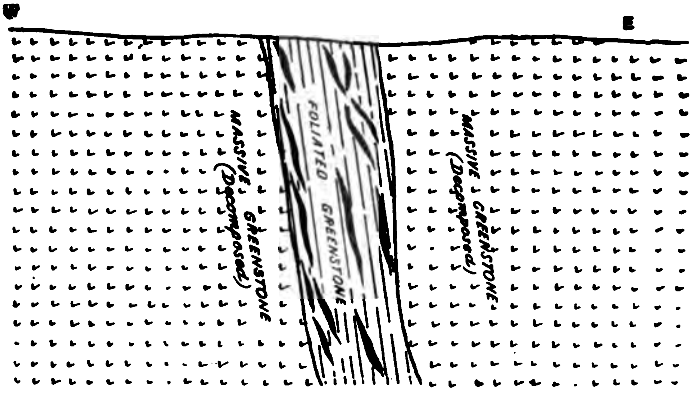
The main shaft is down 150 feet to water, and drives have been put in along the reef at 100 and 150 feet levels; about 150 feet of driving and a good deal of stoping have been done at the 100 feet level, and about 300ft. of driving, but practically no stoping at the 150ft.; the reef is bunchy, varying from 1 to 3 feet, but averaging, on the whole, about 2ft. The country is very soft and rotten all through the workings. The water supply is fresh.

INGLISTON G.M.L. 363N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
1901	114·00	245·60	2·15
1902	182·50	211·85	1·16
1903	50·50	43·00	·85
Total	**347·00**	**500·45**	**1·44**

INGLISTON EXTENDED G.M.L. 398N.—The workings here are on a large lode running about north-east and south-west, and dipping at an angle of about 75° to the eastward. This lode consists of a soft belt of highly altered greenstone throughout which is disseminated a considerable quantity of quartz in irregular veins and masses. As far as opened up at present it is very ill-defined, there being no hard-and-fast boundary between it and the country from which, owing to their both being so decomposed and rotten, it is almost impossible to distinguish it; its lateral limits can at present only be defined by the decrease in its gold contents; its width, as far as defined by these means, varies from 8 to 20 feet. At a depth it will probably be found to consist of a belt of highly-foliated greenstone, carrying a considerable amount of quartz, and will be much more

FIG. 8.


W
E
MASSIVE (Decomposed) GREENSTONE
FOLIATED GREENSTONE
MASSIVE (Decomposed) GREENSTONE

CROSS SECTION OF INGLISTON EX. LODE, MEEKATHARRA.
NOT DRAWN TO SCALE

regular and defined. Several shafts have been sunk on this line of lode, the deepest being 125ft. vertical, and a lot of driving and stoping done on it. The country (greenstone) is very soft and rotten as far as opened up. Water was struck at 125ft., and is fresh.

INGLISTON EXTENDED G.M.L. 398N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
1902	307·00	367·10	1·19
1903	854·25	644·90	·75
Total	**1,161·25**	**1,012·00**	**·87**

INGLISTON CONSOLS G.M.L. 475N.—On this lease a shaft has been put down to a depth of 45ft., for the purpose of working a small quartz reef, running about north-east and south-west. Work is at present being carried on at the 35 feet level, where a couple of short drives have been put in, and a little stoping done. The main reef, which, as far as opened up, has a very irregular course, varies in width from a mere thread to two or three feet, and dips at a fairly flat angle to the east; its gold contents are very patchy, some of the makes of stone being very rich, while others are practically barren. A second small reef comes in from the north-west just at the shaft; this reef has the same characteristics as the other, viz., no defined course, and consisting of a series of short irregular bunches of stone, some of which are very good, and others no good at all. Two or three other small leaders have also been cut, but both these and the main one are so irregular, and so little work has been done upon them, that it is almost impossible to say what is their true course. The quartz in each of the reefs is white and glassy, and carries a considerable quantity of talc in cavities. The country is very soft kaolinised greenstone.

INGLISTON CONSOLS EXTENDED 475N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
1902	...	...	...
1903	59·25	267·65	4·51
Total	**59·25**	**267·65**	**4·51**

The following table shows the gold returns from the leases at Meekatharra, other than those already mentioned, up to the end of 1903:—

Name of Lease.	No. of Lease.	Tons of Ore treated.	Ozs. of Gold therefrom	Average ozs. per ton.
Albion	337N	25·00	10·20	·40
Blue Danube	252N	77·50	199·25	2·57
Calliope	450N	26·50	15·75	·59
Centaur	272N	99·00	88·12	·89
Halcyon North	318N	107·25	100·15	·93
Lost Cop	488N	56·00	21·75	·39
Phœnix No. 1	402N (373N)	144·33	142·93	·99
Phantom	416N	243·00	227·65	·94
Sirdar	246N	147·00	*207·51	1·41
Tidal Wave	411N	20·75	7·10	·34
(H. Brooking)	(unregistered)	18·75	7·40	·39
(Osborne and Campbell)	(unregistered)	19·75	11·95	·60
(Vollmer and party)	Q.P.P.A. 131N	7·00	4·40	·63
Sundry claims	...	171·50	217·05	1·26
Sundry parcels at public battery...	...	...	†86·65	...

* Includes 64·01ozs. dollied and specs. † By cyanide.

Abbotts.

The mining centre of Abbotts is situated about 40 miles to the north of Nannine. The country here is rough and hilly, the hills being of the usual type of greenstone and usually capped with a considerable thickness of ironstone gravel deposits, these being especially plentiful to the eastward of the townsite. These gravel beds (laterite) are often as much as 50ft. in thickness, but are of poor quality; they frequently contain caves of considerable size, in which are often found small deposits of an impure natural bitumen similar to that found at the Wilgie Mia* (Weld Range), Boogardie,† and other places on the Murchison Goldfield.

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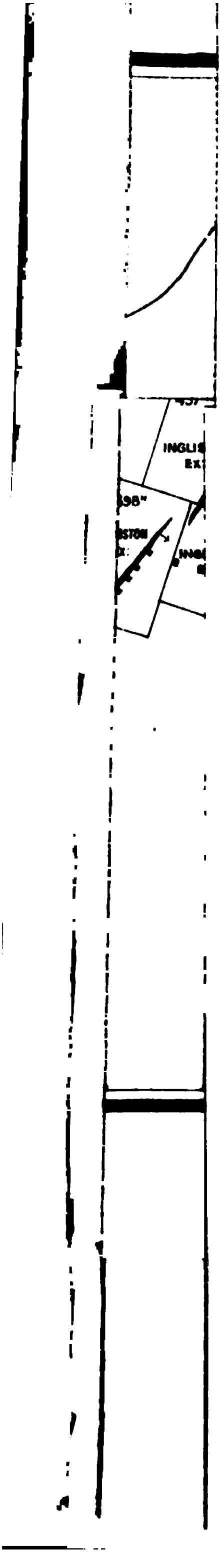
* *Vide* page 79. † Geological Survey, Bulletin 8, page 15.



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The greenstone belt is some ten miles in width, and is bounded on both sides by belts of granite, that on the western side running about north-east, and that on the east nearly north and south (*i.e.*, where seen, viz., at a point about due east of the townsite). Abbotts itself is situated in about the middle of this belt. A large number of quartz reefs run in all directions through the greenstone ridges to the east of the townsite, some of the outcrops being of considerable size, but having no length or regularity. The reefs which are being worked have a trend almost due north and south, extending in one case for over a quarter of a mile; they are not large, but are very regular and well-defined and run very nearly vertically.

Water is obtained at a depth of about 180ft., and is drinkable, but not good. At present most of the water for domestic purposes is obtained from the Government well, about three miles to the north of the townsite; the water level here is about 50ft. and the supply is excellent.

Mining operations were very quiet at Abbotts at the time of my visit (December, 1903), only two mines being worked, and one of these only in a very small way by a party of three tributers.

The Mines.

The following is a brief description of these two mines as far as I was able to examine them:—

Murchison King G.M.L. 248n, 172n, etc.—The main line of reef being worked on this property runs on an almost due north and south bearing through about the centre of the leases; it is of white quartz and is about two feet in width, bunching in places to as much as eight feet, with a dip of about 80° to the eastward, and can be followed on the surface for over a quarter of a mile; several shafts have been put down and a lot of work done on it. The main working shaft is down 300 feet, and drives have been put in from it at 200 and 300 feet, and one also at the 150-feet level from an underlay shaft six or eight chains south of the main shaft; this drive has been put in some 700 feet south and 250 feet north, and the reef stoped out to the surface for this length. A drive was also put in 200 feet farther south than this, at the 80 feet level, and this block taken out to the surface. A crosscut has also been put in from this underlay shaft at the 150-feet level for a distance of 275 feet westerly, to cut a second parallel reef. This reef is from 18 inches to two feet in width, and runs parallel to the main reef; between 500 and 600 feet of driving have been done on it, and the greater part of this length stoped out to the surface. From the main shaft the drive on the eastern reef at the 200-feet level is in 300 feet south and 600 feet north, and the whole of this block has been stoped out up to the 135-feet level; the drive at the 300-feet is in 250 feet south and 300 feet north, and this block has been stoped out up to the 200-feet level. At the time of my visit the bottom workings were flooded and I was only able to examine the 150 feet level; the reef here is very regular and for the most part maintains a uniform width of about two feet; a few larger sized bunches of stone occur here and there however. The country down to this level is very soft and broken. Intermediate between the main reef and the western one are several small parallel reefs up to a few inches in width; no work has, however, been done upon them.

The water supply of the mine is fresh.

New Murchison King G.M.Ls. 172n, 247n, 248n.

—	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
Previous to 1897 ...	5·00	15·00	3·00
1897	990·00	1,042·65	1·06
1898	2,516·00	4,020·06	1·59
1899	1,430·00	1,574·05	1·10
1900	3,274·00	6,579·55	2·01
1901	2,551·00	3,732·55	1·46
1902	2,690·50	2,938·45	1·09
1903	2,445·00	1,461·75	·59
Total	**15,901·50**	**21,364·06**	**1·34**

Abbotts Proprietary G.M.L. 171n (Mt. Vranizan).—This mine was almost abandoned at the time of my visit, and as the lower workings were flooded I was unable to examine them. A good deal of work has been done on the property, and the reef has been worked out for a length of 400 feet down to the 400-feet level (on the underlay); a main vertical shaft has also been put down to a depth of 250 feet. The reef, which runs on a bearing slightly west of north and east of south, and dips to the westward at an angle of about 70°, is somewhat irregular, and varies from a few inches up to four feet; it is very much twisted and faulted, especially at the northern end; a considerable quantity of manganese is associated with the stone, especially at the points where it pinches.

Several other smaller parallel reefs run through the property farther to the westward; the most easterly of these has had a little work done on it, but it was not much good.

The country consists of fine-grained greenstone, very soft in the upper workings, but hard and settled in the bottom level; the water supply is fresh.

At the time of my visit the property was in the hands of a small party of tributers, who were engaged principally in taking out small bodies of stone which had been left by the original company in the upper levels.

BULLETIN No. 14 PLATE IX.

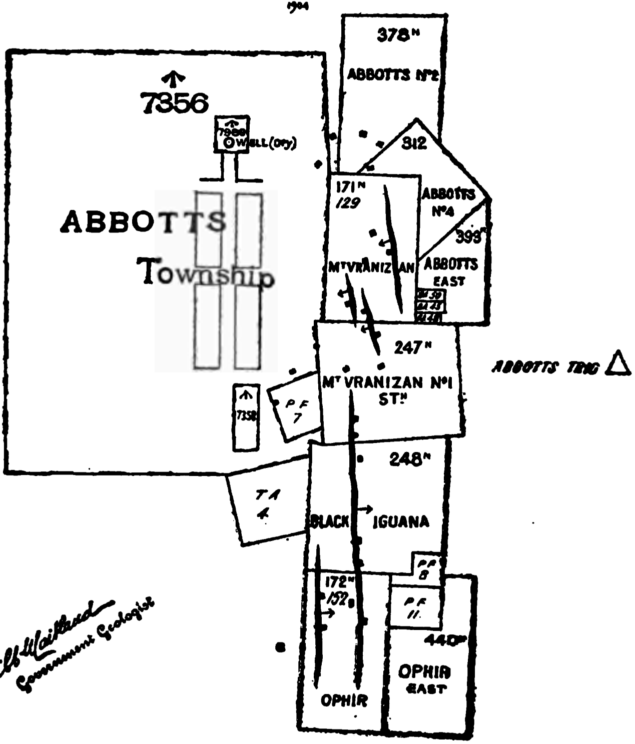
MAP
OF THE AURIFEROUS QUARTZ REEFS
OF
ABBOTTS
MURCHISON G.F.

BY

C.G. Gibson

ASSISTANT GEOLOGIST

1904



A. Gibb Maitland
Government Geologist

EXPLANATION

Quartz Reefs ....

Shafts ....

Mining Leases { Name of .... OPHIR
Registered No of 172N
Post No of 152
Boundaries of .... }

Business Areas .... B.A

Tailings do .... T.A

Poultry Farms .... P.F

0 10 20 30 40

Scale of Chains

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MT. VRANIZAN G.M.L. 171N.

—	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
Previous to 1897 ...	372·00	277·00	·74
1897	...	...	...
1898	1,014·00	1,018·85	1·00
1899	3,030·00	3,328·95	1·09
1900	2,670·00	3,920·20	1·46
1901	1,058·00	1,118·10	1·05
1902	1,934·00	1,769·60	·91
1903	3,228·00	1,982·70	·61
Total ...	**13,306·00**	**13,415·40**	**1·01**

The following table shows the total gold returns from the leases at Abbotts, other than those already mentioned, up to the end of 1903 :—

Name of lease	No. of Lease.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
Cashman's Reward...	382N	128·50	184·60	1·43
White Horse ...	253N	58·50	65·00	1·11
Sundry claims ...	...	7·50	9·95	1·32

The Country between Nannine, Munarra Gully, and the Weld Range.

(Sixteen miles south-west and 35 miles west.)

The granite, which makes its appearance at Nannine townsite, continues for about eight miles, the country consisting principally of level plains covered with loose sandy soil, when its place is taken by low rough greenstone ridges, the junction of which, with the granite, runs apparently about north and south. These greenstone ridges continue unbrokenly to Munarra Gully. At a spot about a mile from their junction with the granite they are traversed by a series of parallel belts of hæmatite-bearing quartzites, which run in a north and south direction, and are apparently the northern continuation of those occurring at Stake Well.

For the first seven or eight miles after leaving Munarra Gully the track passes over low greenstone ridges with intervening flats, and then for a further distance of about eight miles over a belt of granite running north and south, and for the most part level, and covered with a shallow depth of loose sandy soil. After this comes a belt of greenstone schists about a mile in width, and then a second belt of granite similar to the preceding, and extending for a further distance of eight miles. From this point to the Weld Ranges the country is flat, and covered with a considerable thickness of loose reddish soil evidently derived from and overlying greenstones. The Weld Ranges are of massive greenstone, intersected by bands of hæmatite-bearing quartzites, and rise above the surrounding plains to a height of about 800 feet.

The Country between the Weld Range and Lake Austin.

(Forty miles south-south-east.)

From the Weld Ranges to about two miles from Cuddingwarra the country consists of level plains covered with the usual superficial deposits, these for the first seven miles overlying greenstones, and from that point onward overlying granite which occasionally rises through them in the form of low bare hills, especially in the neighbourhood of Coodardy Station. At Cuddingwarra the greenstones appear again in the form of low ridges extending for four or five miles, when they again give place to the plains which extend to near Day Dawn, where there are more greenstone ridges running about north and south and a couple of miles across. From this point to Lake Austin the level plains continue uninterruptedly.

The Iron Deposits of the Weld Range (the Wilgie Mia).

The Wilgie Mia is situated about five miles to the east of the Weld Hercules G.M. and some two miles south-west of Mt. Lulworth on a ridge running in an east and west direction along the south side of the Weld Range. The Wilgie Mia is of considerable interest owing to the occurrence of iron ores, which bid fair to become of some importance in the future. It has been thus described by Mr. H. P. Woodward, late Government Geologist, in his report on the Murchison Goldfield * :—

> " In the Weld Range is situated the celebrated Wilgie Mia, which is certainly one of the most striking things to be seen in this colony. It is probably one of the largest iron lodes in the world, consisting almost entirely of hæmatite, which at the surface and in the cavities assumes the botryoidal form, which has given rise to the idea that it is a lava flow.
>
> " It is situated on the east side of the Weld Range and runs east and west, dipping north, following the main strike of the rock.
>
> " In these lodes there are soft bands, often clayey. These the kangaroos scratch out, forming caves, and it is probably in this way that the natives first made the discovery that this lode could be easily worked by following these beds. It has now been opened up as a huge pit or quarry to a depth of about 100 feet. This is entered, near the top of a hill 70 or 80 feet above the plain (400 feet. C.G.G.), by a hole about 50 feet across; then a steep descent commences over the talus in a south-easterly direction. At the bottom it spreads out to about 50 yards wide, with the roof some 50 feet above and numerous cave-like galleries running into the face in all directions.
>
> " The Wilgie is worked by cutting round a mass of it, then wedging it off. This work, although very primitive, is very interesting, as these natives

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* The Murchison Goldfield, by H. P. Woodward, Government Geologist, page 20. Perth: By Authority, 1893.

work with their wooden tools much in the same manner as the ancient miners did in Great Britain with stone hammers. There are also rude attempts at staging to allow the miners to work up into the roof when veins of sufficiently good quality run that way. In contemplating this pit one is struck by the vastness of the work, and when we consider the small quantity of Wilgie that can be required it must have been worked for centuries. Of course it was worked on a much larger scale before the white invasion of Western Australia and was probably traded great distances.

"As far as the lode itself is concerned, it is most magnificent iron ore, and considering its size will, without doubt, be of great value in the future.

"It has been generally supposed that cinnabar existed here associated with volcanic rocks; but there is nothing of the sort, the Wilgie itself being red hæmatite and red and yellow ochre."

The deposit, which is of almost pure hæmatite, is, roughly, some 150 feet to 200 feet in width, and forms a ridge about three miles in length, rising in places to a height of 400 feet above the plain. The deposit is undoubtedly of similar origin to the hæmatite-bearing quartzites which form the main axis of the Weld Range, and which are so prevalent throughout the whole of the Murchison Goldfield, the only difference being that in this case silica is almost entirely absent and the lode is composed of almost pure hæmatite, with magnetite and limonite, resulting from the gradual replacement of greenstone schists by iron-bearing solutions.

The dip of the lode is very nearly vertical. As sulphides are not likely to be met with above water level—which is about 60 feet below the surface of the plain—it will be thus seen that there is an immense body of very high grade iron ore here (*vide* analyses).

A second somewhat similar deposit is said to exist about two miles to the north-eastward of Mt. Lulworth. Several samples of ore shown me from this locality were in appearance of the same quality as [**5356**]; owing, however, to the dryness of the season and lack of horse feed, I was unable to stay long enough to examine this deposit.

These deposits, which are undoubtedly some of the richest in the world, are at present rendered practically valueless owing to their inaccessibility and distance from a suitable coalfield.

In the tunnels and caves in the sides of the Wilgie Mia are found considerable deposits of an impure natural bitumen [**5361**]; this, from its general appearance and mode of occurrence, I am inclined to think is only a decomposition product of the excreta of bats and wallabies.

The following are three partial analyses of samples of iron ore from the Wilgie Mia, and one also of a sample [**5360**] of hæmatite-bearing quartzite from the Weld Range:—

Analyses—	I.	II.	III.	IV.	
Metallic iron ...	63·87 ...	64·36 ...	68·83 ...	35·50	per cent.
Silica	2·48 ...	1·38 ...	1·00 ...	43·42	„
Phosphorus ...	·090 ...	·052	small trace	·089	„
Sulphur ...	·033 ...	·023 ...	·035 ...	·036	„
Water (hyg.) ...	·89 ...	·57 ...	·19 ...	·15	„
Water (combined)	1·52 ...	·60 ...	·35 ...	4·17	„

Traces only of titanium were present in these samples.

Localities—

I. is from what is known as the Little Wilgie Mia, about one and a-half miles west of the Wilgie Mia and on the same lode; it represents a sample taken across about 20 feet of the lode at a depth of about 15 feet from the surface.

II. is from the Wilgie Mia, and is a sample taken across a face of the lode about 150 feet in width and at a depth of about 100 feet from the surface (*i.e.*, from the top of the hill).

III. [5356] is a picked sample of ore from a surface boulder at the Wilgie Mia; there are, however, a good many thousands of tons of this class of ore on the surface.

IV. [5360] is a typical sample of the hæmatite-bearing quartzites which traverse the Weld Range from end to end, and is from a spot about three-quarters of a mile west of the Weld Hercules G.M.

Samples I., II., and III. represent very rich hæmatite ores, extremely low in sulphur and silica and free from titanium. The phosphorus percentage in I. is somewhat above the Bessemer limit; pig iron smelted from it would, however, make good stock for the production of "basic" steel. The phosphorus percentage in sample II. is just about the permissible limit for the cheaper Bessemer process; but sample III. is extremely pure and low in phosphorus, and as there is a considerable quantity of this quality of ore present, the whole deposit, if it is ever worked, will probably prove of such grade as to permit of the use of this process of steel manufacture. Regarding the probable quantity of ore present, an estimate has been made of the amount in sight as, roughly, 26½ million tons. To obtain these figures the length of the deposit has been taken as three miles, the average width as 150 feet, and the average height of the cap of the lode above the plain to be 100 feet, all of which dimensions are, if anything, a long way on the safe side; taking the weight of a cubic foot of the ore to be 250lbs., this gives the amount of ore actually above the level of the surrounding plains to be as above stated, roughly, 26½ million tons. In addition to this deposit, there are the hæmatite-bearing quartzites which traverse the Weld Range from end to end, and of which IV. **[5360]** is a typical sample. These deposits, of which there is practically an inexhaustible supply, and amongst which there are said to be other rich patches similar to the Wilgie Mia deposit,* though of rather too low grade for smelting purposes as they now exist, could, with the employment of suitable concentrating machinery, be converted into first-class ores, and during this process of concentration would doubtless lose a considerable portion of their phosphorus contents. These remarks also apply to the hæmatite-bearing quartzites found in such large quantities all over the Murchison goldfield, several analyses of which are given in this report and which, as far as sampled at present, may be said to average from 30 to 40 per cent. of metallic iron. With regard to the probability of these ores living to a depth, similar deposits (of hæmatite-bearing quartzites) have been proved to exist to a vertical depth of 250 feet at Boogardie and Lake Austin, apparently without any change in their mineral constitution beyond a slightly increased sulphur percentage.

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* *Vide* page 79.

The Titaniferous Iron Deposits of Gabanintha.

As mentioned on page 46, there is a large deposit of titaniferous magnetite about half way between Gabanintha and Star of the East. As shown by the analysis of a typical sample given on the same page, this is, except for the presence of the titanium, an extremely pure ore, sulphur and phosphorus both being almost entirely absent.

The deposit extends over a length of about two miles and varies in width from 50 to 100 feet, rising in places to over 60 feet above the surrounding country; taking it as having an average width of 50 feet, an average height of 25 feet above the plain, and a length of two miles, this gives, roughly, one and a-half million tons as the quantity of ore actually above the surface of the ground.

The high percentage of titanic acid in this will always tend to preclude its being worked profitably, although this is a difficulty which at the present time is being rapidly overcome.

With regard to the smelting of titaniferous iron ores, the following extract is taken from Mr. J. B. Jaquet's report on the iron ores of New South Wales:—[*]

> According to Mr. T. Turner, titanferous iron ores are difficult to smelt owing to the formation of cyano-nitride of titanium, which collects in the hearth of the furnace. [†] Many years ago a company—the Norwegian Titanic Iron Company—was formed for the purpose of smelting, without mixture of other ores, ilmenite obtained from Norway. Mr. W. M. Bowron, who was employed as chemist by the company, says, concerning their operation, as follows:—[‡]"The process, regarded as a process, was a perfect success; but the enormous quantity of fuel required, the small quantity of iron in the ore, and the cost and uncertainty of importation militated seriously against its commercial success, and a few years saw the attempt abandoned." After describing the process in detail, Mr. Bowron says:—"If, then, the use of titaniferous ores involves extra fuel, low heats and slow driving, and makes white iron, what is the inducement to use them? I can only answer that for ordinary use they are wholly unsuitable; but for making a forge iron that has brought double the market price of common iron, for use as a mixture to impart the property of cold toughness to other iron, or for making an iron to be mixed with other irons that are not quite up to requirements for boiler plates, for blooms, or for an extra good iron generally, these ores are most valuable." It has been found that titanic acid requires a greater heat for its reduction as compared with oxide of iron, and so, when smelting titanifefous iron ores, it is important that the temperature of the furnace should be kept as low as possible, in order that the titanic acid may pass on unaltered into the slag.
>
> The question of smelting titanic ores has been discussed by Mr. A. T. Rossi. [§] He says that American ironmasters have generally thought that mixtures containing more than 1·25 per cent. of titanium could not be smelted on account of the tendency which this element has to make the slag pasty. Ores containing 5 to 10 per cent., or even 15 to 20 per cent., have been smelted in Norway when the fluxes have been so chosen as to produce a slag approximating in composition to certain natural compounds of titanium, such as sphene. In a letter to the *Engineering and Mining Journal*, Mr. Rossi cites many opinions favourable to the employment under certain circumstances of pig iron produced from titaniferous ores[||].

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[*] "The Iron Ore Deposits of New South Wales," by J. B. Jaquet, F.G.S., pages 81, 82. Geol. Surv. of N.S.W. Sydney: By Authority, 1901.

[†] The Metallurgy of Iron, by T. Turner, page 53.

[‡] Trans. Am. Inst. Min., Eng., 1882. XI., p. 159.

[§] Journ. of Am. Chem. Soc., 1890, p. 91.

[||] Eng. and Min. Journal, 10 Mar., 1900, p. 284.

Other Iron Deposits of the Murchison Goldfield.

The following extracts are taken from a report by the Government Geologist, appearing in the Annual Report of the Geological Survey for the year 1902*, and are inserted in this place, referring as they do to the ores of the Murchison :—

The iron deposits of the State, so far examined, can be broadly separated into two main divisions—

(a.) The ores associated with the crystalline schists and other allied rocks; and

(b.) The superficial deposits of limonite (laterite ore) which occupy extensive areas in many and widely-separated portions of the State, and the soft porous deposits of hydrated oxide or iron (bog ore) of comparatively recent origin. . . .

The important ores associated with the crystalline schists are developed most extensively in the watershed of the Murchison River, more especially between 25 degrees and 28 degrees south latitude and 116 and 119 degrees east longitude. . . . These deposits consist of highly-inclined beds, bands and lenses of almost pure hæmatite (occasionally magnetite) or admixtures in all proportions of hæmatite and quartz. . . .

The sigma-shaped range of hills on the west side of the Murchison, of which Mts. Taylor, Hale, Matthew, Yarrameedie, and Erawandoo form the most prominent summits, is remarkably prolific in iron-bearing schists. The summit of Mt. Hale is formed of contorted quartz schists with bands of hæmatite, which occur in the lenticular masses; some bands are often as thin as a sheet of paper, whilst others widen out to considerable dimensions. One band measured 70 feet across, and outcropped for over a quarter of a mile, but varied in thickness in different parts. There were similar bands parallel to it, and equally persistent along the strike. Just under the western summit of Mt. Hale the quartzite is replaced by a great bed of hæmatite, several huge monoliths of which stand out prominently on the range. This hæmatite can be followed along the range to a point just south of the summit of Mt. Matthew. A partial analysis made in the Departmental Laboratory of a sample of this bed gave results as follows :—

Ferric oxide Fe_2O_3	... ...	94·05 per cent.
Ferrous oxide FeO	... ...	0·97 ,,

equal to 66·59 per cent. of metallic iron.

The outcrop of a bed of ironstone forms a conspicuous feature on the surface at the foot of the Mount Narryer Range. The bed, which is vertical, attains a thickness of eight or nine feet, and rises about two feet above the ground.

The following table shows the position of the Murchison deposits with reference to the nearest coalfield on the Irwin River, and the means of transport thereto :—

Deposit.	Distance from nearest seaport by rail and road.	Distance from railway line.	Distance from nearest coalfield by rail and road.
Mt. Hale	362 miles, Geraldton	100 miles, Cue ...	441 miles, Irwin River
Mt. Narryer	362 ,, ,,	100 ,, ,, ...	441 ,, ,,
Wilgie Mia	312 ,, ,,	50 ,, ,, ...	391 ,, ,,
Gabanintha	332 ,, ,,	20 ,, Nannine	411 ,, ,,

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* The Iron Deposits of Western Australia, by A. Gibb Maitland, Government Geologist. Annual Progress Report of the Geol. Survey for the year 1902, page 8. Perth : By Authority, 1903.

Appendix I.

LIST OF SPECIMENS COLLECTED IN NORTH MURCHISON DISTRICT.

Registered No. of Specimen.	Registered No. of Microscope Slide.	Name of Specimen.	Locality.	Remarks.
5316	460	Amphibolite	30 chains W. of Boyd's Reward G.M.L. 64N, Tuckanarra	*See* page 27
5317	461	Diorite (quartz diorite) ...	30 chains S.W. of Boyd's Reward G.M.L. 64N, Tuckanarra	*See* page 27
5318	462	Granite (granite aplite) ...	5 chains E. of G.M.L. 146N, Tuckanarra	*See* page 28
5319	...	Hæmatite-bearing quartzite ...	G.M.L. 86N, Tuckanarra	
5320	...	Do. do. ...	Telegraph line, 8½ miles N.E. from Tuckanarra	
5321	..	Do. do. ...	Near Cable G.M.L. 282, Tuckanarra	
5322	...	Do. do. ...	40 chains E. of Maybelle G.M.L. 1270, Tuckanarra	
5323	...	Do. do. ...	do. do. do.	
5324	...	Do. do. ...	Telegraph line, 8½ miles N.E. from Tuckanarra	For analysis, *see* page 28
5325	...	Do. do. ...	do. do. do.	
5326	...	Do. do. ...	209-mile peg, telegraph line, Tuckanarra	
5327	...	Do. do. ...	Telegraph line, 8½ miles N.E. from Tuckanarra	For analysis, *see* page 28
5328	...	Do. do. ...	100-feet level, Bachelor G.M., Tuckanarra	
5329	463	Amphibolite (diorite ?) ...	5 chains N. of G.M.L. 453N, Quinns	*See* page 40
5330	...	Hæmatite-bearing quartzite ...	15 chains N. of G.M.L. 453N, Quinns	
5331	...	Do. do. ...	Sir Garnet G.M.L. 23, Quinns	For analysis, *see* page 41
5332	..	Asbestos (impure)	10 chains S.W. of G.M.L. 478, Quinns	
5333	464	Granitic schist	G.M.L. 467, Quinns	*See* page 40
5334	473	Basic tuff	Summit of Mt. Yagahong, Gabanintha ...	*See* page 44
5335	474	Do.	Half-way up Mt. Yagahong, Gabanintha	
5336	465	Amphibolite	Sovereign G.M.L. 397, Gabanintha	*See* page 45
5337	...	Copper ore	Mountain View G.M.L. 379, Gabanintha	

LIST OF SPECIMENS COLLECTED IN NORTH MURCHISON DISTRICT—*continued.*

Registered No. of Specimen.	Registered No. of Microscope slide.	Name of Specimen.	Locality.	Remarks.
5338	...	Copper ore (chrysocolla)	G.M.L. 340, Gabanintha	For analysis, *see* page 48
5339	...	Sulphide copper ore	do. do.	
5340	...	Copper ore	M.L. 1N, Gabanintha	
5341	...	Asbestos	do. do.	*See* page 48
5342	...	Calcite	Star of the East G.M.L. 344, Gabanintha	
5343	466	Granitite (granophyre)	Star Extd. G.M.L. 241, Gabanintha	*See* page 46
5344	...	Magnetite	40 chains E.N.E. of G.M.L. 241, Gabanintha	For analysis, *see* page 46
5345	467	Granite	40 chains N.E. of G.M.L. 32N, Gabanintha	*See* page 45
5347	...	Hæmatite-bearing quartzite	40 chains N. of Daisy G.M.L. 457, Nannine	
5348	468	Felsite	30 chains N. of Daisy G.M.L. 457, Nannine	*See* page 56
5349	469	Hornblende granite	G.M.L. 115N, Nannine	*See* page 55
5350	470	Altered pyroxenite	Champion G.M.L. 17N, Nannine	*See* page 54
5351	471	Hornblende granite	G.M.L. 13N, Nannine	*See* page 56
5352	...	Hæmatite-bearing quartzite	30 chains S. of G.M.L. 249, Nannine	For analysis, *see* page 55
5353	...	Do. do.	1 mile N.E. from 21-mile peg, Meekatharra	
5354	472	Granite (biotite granite ?)	1 mile N. of Havelock G.M.L. 236, Meekatharra	*See* page 61
5355	...	Iron ore (hæmatite)	1½ miles W. of Wilgie Mia, Weld Range	For analysis, *see* page 79
5356	...	Do. do.	Wilgie Mia, Weld Range	For analysis, *see* page 79
5357	...	Do. do.	do. do.	
5358	...	Do. do.	do. do.	
5359	...	Do. do.	do. do.	
5360	...	Hæmatite-bearing quartzite	¾-mile W. of Weld Hercules G.M., Weld Range	For analysis, *see* page 79
5361	...	Natural bitumen	Wilgie Mia, Weld Range	*See* page 79
5362	...	Copper ore	After Many Years G.M.L., Munarra Gully	
5363	...	Gold in quartz	Boyd's Reward G.M., Tuckanarra	
3796	258	Grano-diorite	Agamemnon G.M., Cue	*See* page 14
3832	...	Norite	From hill between Lady Forrest and Polar Star G.M., Cue	*See* page 15

3823	...	Amphibolite	9 chains S. of Princess Extended G.M.L. 1232, Cue	*See* page 15
3847	...	Do.	Water reserve 7745, Cue	*See* page 15
3976	...	Felspar porphyry	2,030ft. level; D.D. bore on G.M.L. 226, Day Dawn	*See* page 15
5106	344	Diorite	Mainland Consols G.M.L. 171, Lake Austin	
5107	...	Hæmatite-bearing quartzite ...	N.E. of Ingot G.M.L. 204, Lake Austin	
5108	845	Diorite	G.M.L. 765, Lake Austin	
5109	...	Hæmatite-bearing quartzite ...	North end of Island, Lake Austin	For analysis, *see* page 19
5110	...	Do. do. ...	do. do.	For analysis, *see* page 19
5111	843	Diorite	20 chains N.W. of G.M.L. 234, Island Lake Austin	
5112				

CHAS. G. GIBSON, B.E.,
Assistant Government Geologist.

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UNIV. OF MICH.

1908.

WESTERN AUSTRALIA.

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THE GEOLOGICAL FEATURES AND MINERAL RESOURCES OF THE PILBARA GOLDFIELD.

BY

A. GIBB MAITLAND,
GOVERNMENT GEOLOGIST.

WITH AN APPENDIX BY **A. MONTGOMERY, M.A., F.G.S.**
STATE MINING ENGINEER.

Re-issued under the authority of the Hon. H. GREGORY, M.L.A.,
Minister for Mines.

WITH TWENTY MAPS AND SIXTY-THREE FIGURES.

FOR THE WESTERN AUSTRALIAN GOVERNMENT BY
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PREFATORY NOTE

Owing to the demands on the part of the General Public for copies of the three Bulletins, Nos. 15, 20, and 23, the Government decided upon reprinting them in one volume, along with the Report of the State Mining Engineer, in order that all the official data upon the district might be brought together in a handy form under one cover.

Only such alterations have been made in the text of the original Reports as have been necessitated by the use of one volume in lieu of three for the publication.

The Gold Mining Statistics differ from those in the State Mining Engineer's Report, which forms Appendix III., in that, in the latter, the figures give the yield in ounces of fine gold, but owing to the shortness of time available for republication it has not been found possible to reduce the former tables to fine ounces also.

During the progress of the fieldwork I was assisted throughout by Mr. H. W. B. Talbot, Field Assistant, to whose co-operation the comparatively rapid completion of the field maps was in no small measure due.

A. GIBB MAITLAND,
Government Geologist.

Geological Survey Office, Perth,
10*th February* 1908.

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Geological Features and Mineral Resources of the Pilbara Goldfield

DIVISION I

PRELIMINARY REPORT, 1903

INTRODUCTION

The Pilbara Goldfield is situated in latitude 21 degrees south, and is, with the exception of Kimberley and Yilgarn, the oldest and perhaps the least known of any of the mining fields of Western Australia.

It is bounded, as defined by the authorities, by :—

> "a line starting from a point on the sea-coast eastward from Condon Creek and extending through the summit of Poolingerena (or Mount Blaze) to a spot due north from the summit of Mount Macpherson ; then south through the said summit to a spot due east from the summit of Mount Marsh, on the Upper Fortescue River; thence due west through the summit of Mount Marsh to the right bank of the Fortescue River, along it downwards to Survey Station V 23 ; thence in a northerly direction through Survey Station V 32 to the right bank of the Cocreaca branch of the Yule River, and along the right banks of the Cocreaca Creek and the Yule River downwards to the sea-coast, and along the sea-coast eastward to the starting-point ; excluding all town sites within the said boundaries."

The area included within these boundaries embraces about 34,880 square miles.

Prospecting has been carried out in the Pilbara District since the year 1877, but serious mining operations can scarcely be said to have yet begun.

The gold yield of the field, as reported to the Department of Mines up to the end of 1903, has been 119,383·34 ozs., obtained from the milling of 54,883·95 tons of ore, thus giving an average yield of 2·17 ozs. per ton.

The following table gives the yield of the field up to the close of the past year, as shown by (*a*) the figures furnished to the Department of Mines, and by (*b*) the data in the archives of H.M. Customs House and the Perth Mint. It will be noticed that in almost every case there is a difference between the two sets of figures. Up to the end of 1903 there have been officially reported to the Mines Department 119,383·34 ozs. of gold from the different centres ; the Customs and Mint authorities, however, give the gross weight of 208,810·39 ozs. (with a fine gold content of 185,886·47 ozs.)

being 89,427·05 ozs. in excess of the figures furnished to the Mines Department. This discrepancy may perhaps be accounted for by the difficulty experienced in obtaining a record of the alluvial gold, and also by the fact that a good deal of the gold won in the early days was probably never officially reported. In addition to the gold, there has also been raised, up to the close of the year 1903, 1,442·26 tons of tin ore, valued at £92,984.

Table showing the Yield of the Pilbara Goldfield.

I. GOLD YIELD.

Year.	Ore Crushed.	Yield of Gold therefrom.	Gold Exported and received at the Perth Mint.		Remarks.
			Gross Weight.	Fine Contents.	
	Tons.	Ozs.	Ozs.	Ozs.	
1889	11,121·10	a 28,470·56	b11,170·00	9,992·63	a. Includes 2,082 ozs. from unknown tons b. Includes export from West Pilbara
1890			b16,055·31	14,363·01	
1891			b11,875·00	10,623·32	
1892			b12,892·80	11,533·84	
1893			b11,698·50	10,465·43	
1894			b16·254·50	14,541·20	
1895			b19,522·40	17,464·65	
1896			b11,810·11	10,565·27	
1897	5,138·70	6,825·26	b11,955·87	10,695·67	
1898	6,719·75	c 14,413·79	11,662·56	10,433·27	c. Includes 2,000 ozs. of alluvial and 102 ozs. dollied and specimens
1899	7,567·55	d 19,291·98	20,526·20	18,362·65	d. Includes 2,608·29 ozs. alluvial and 833·72 ozs. dollied and specimens
1900	6,173·71	e 16,616·85	17,140·51	15,333·82	e. Includes 1,527·54 ozs. of alluvial and 88·92 ozs. dollied and specimens
1901	5,414·11	f 10,264·32	11,320·40	10,260·43	f. Includes 1,050·55 ozs. of alluvial and 275·52 ozs. dollied and specimens
1902	7,163·38	g 12,170·46	10,706·03	9,199·50	g. Includes 679·05 ozs. of alluvial and 41·37 ozs. dollied and specimens
1903	5,585·65	h 11,330·12	14,220·20	12,051·78	h. Includes 1,180·48 ozs. of alluvial and 741·97 ozs. dollied and specimens
Total	54,883·95	119,383·34	208,810·39	185,886·47	

Table showing the Yield of the Pilbara Goldfield.

II. TIN YIELD.

Year.	Ore Raised.	Value thereof.
	Tons.	£
Previous to 1899 .	75·45	4,419
1899	57·50	3,612
1900	387·87	27,174
1901	412·98	21,148
1902	216·35	15,103
1903	292·11	21,528
Total	1,442·26	92,984

PART I.—GENERAL GEOLOGY

SECTION I.—THE SALIENT GEOLOGICAL FEATURES

AN account of the geology and mineral resources of the district was given by Mr. H. P. Woodward in the years 1888[1] and 1890.[2] In this latter report it was set forth that—

> in a country of this description a more or less detailed geological survey would be of very great assistance to the diggers . . .

At a later period, Mr. S. J. Becher, who acted as Inspector of Mines, supplemented the data acquired by Mr. Woodward,[3] and added somewhat to our meagre stock of knowledge.

Mr. R. Neil Smith, a Mining Engineer, employed by the Department, dealt in an official report with a portion of the district, and added a few facts to the scanty knowledge of Pilbara.[4]

To carry out a complete geological examination of a tract of country so extensive, in the space of time that it was possible to devote to the work, was found to be quite impossible. In a reconnaissance carried out along the main roads or tracks—where no small portion of a geologist's time is occupied in overcoming the difficulties of the route and locating positions—it will readily be understood how impossible it is to acquire much knowledge of minute details.

The present report may be regarded as the first result of an attempt at a systematic and reasonably detailed examination of the broader geological features of the district, in so far as they have any bearing upon economic questions; it refers exclusively to but a small portion of the field. The report includes particulars with reference to the mining centres of Lalla Rookh, North Pole, Talga Talga, Moolyella, Bamboo, Elsie Creek, Boodalyerri, Mosquito, Sandy and Middle Creeks. An attempt has been made to sum up the existing knowledge of the district; but while by far the greater portion of the report is the direct result of my own personal observations, the manuscript reports of the Inspectors of Mines have been laid under contribution when considered necessary. The report is accompanied by a series of geological maps and sections which, in some measure, serve to make the descriptions a little more intelligible.

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[1] H. P. Woodward. Annual General Report for 1888–9. Perth: By Authority, 1890, pp. 35–37.

[2] H. P. Woodward. Annual General Report for the year 1890. Perth: By Authority, 1891, pp. 22–35.

[3] S. J. Becher. Report on the Pilbara Goldfield, 1894–5, with reference to its Geological Character. Appendix 5. Report of the Department of Mines for the year 1895. Perth: By Authority, 1896.

[3] S. J. Becher. Report on the Northern Goldfields. Report of the Department of Mines for the year 1896. Perth: By Authority, 1897.

[4] R. Neil Smith. The Probability of obtaining Artesian Water between the Pilbara Goldfields and the Great Desert. Geological Survey, Bulletin No. 2. Perth: By Authority, 1898.

The district affords better and more continuous sections than are generally to be met with on any of the goldfields of the State which have yet been examined; they thus reveal geological structures which are not to be found in the more southerly districts, and on this account serve to throw light on many obscure points in connection with the geology of other fields.

What are believed to be the oldest rocks occurring in Pilbara are the granites and gneisses, which form the platform upon which the newer formations were laid down, and which everywhere underlie the great plain extending from Port Hedland to Doolena Gorge, on the Shaw River.

To these succeed the greenstone schists and allied rocks, which occupy an extensive area of country, and which appear to be almost everywhere genetically connected with the occurrence of gold. These schists are associated with laminated, sometimes hematite-bearing, quartzites, which may merely represent silicified schists, the silicification having taken place along certain areas to such an extent as to make the rocks resemble fine-grained sedimentary quartzites. The rocks of the greenstone schist series have not been closely studied microscopically, but some, at any rate, appear to owe their origin to the transmutation of eruptive rocks. There are, however, associated with them beds of undoubted sedimentary origin.

Next in antiquity to the greenstone schists comes the series of sandstones, grits, conglomerates, thin limestones, sometimes magnesian, and associated volcanic rocks, so well exposed in many portions of the district. For convenience of description, these will be referred to as the Nullagine Beds. This formation, the actual base of which is rarely seen, forms an important feature in the geology of Pilbara, and none plays so prominent a part in the landscape. The Nullagine Beds cannot be exactly correlated with those yet described in any of the previous official reports on the geology of Western Australia. In their lithological characters and general behaviour they resemble very strongly the quartzites, &c., which form that continuous formation extending from Wyndham to Mount Hart, a prominent summit on the King Leopold Range, in Kimberley, to which reference has been made in a former report.[1]

If a comparision between two regions, separated by about five degrees of latitude, be of any value in correlating strata, then there seem to be very strong reasons for identifying the two series of beds. On the strength, therefore, of the lithological and structural similarity to those of the Leopold Range, the Nullagine Beds are assumed to be of the same age, viz., Cambrian; but in view of the deficiency of our knowledge of these beds, it is obvious that this assumption is more or less guesswork.

Above the Nullagine Beds come the sandstones, limestones, cherts, &c., which form the table-topped hills in the vicinity of the Oakover River. These do not, so far as has yet been noticed, occupy any very extensive area of country, nor are they very thick. They will be referred to as the Oakover beds.

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[1] Annual Progress Report of the Geological Survey for the Year 1901. Perth: By Authority, 1902, pp. 8–9.

The following is the geological record, arranged in the form of a table, as furnished by that portion of the Pilbara Goldfield so far examined:—

Recent	Blown sand.
	Alluvium of the river beds.
	Residual Deposits (sands, laterite, &c.).
Tertiary (?)	Oakover Beds (sandstones, limestones, &c.).
Cambrian (?) . . .	Nullagine Beds (sandstones, grits, conglomerates, limestones, and volcanic rocks).
Archæan (?) . . .	Greenstone Schists and allied rocks (*gold-bearing rocks*).
	Granites and Gneisses (*tin-bearing rocks*).

In addition to the beds above mentioned, a series of igneous rocks have invaded the schists, gneisses, and granites in the form of dykes, which run in long approximately parallel lines. The dykes, which are all basic compounds, often form very conspicuous features in the landscape, owing principally to their black weathered summits, which stand out in bold relief. Mr. F. T. Gregory, in his Journal of the North-West Exploring Expedition in 1861, when traversing that portion of the country now embraced by the Pilbara Field, often described these dykes as "black volcanic ridges" protruding through the crystalline schists and allied rocks. Wherever good sections can be seen of these dykes they invariably have a tendency towards verticality, but do not attain any very great width. So far as any observations have at present been carried, these dykes have no apparent connection with any deep-seated rock of similar composition. Whatever may be the exact age of these dykes, it is quite clear that they are of later date than the first foliation which affected the crystalline schists and allies, and of greater antiquity than that of those faults which almost invariably mark the junction between the Nullagine Beds and the older rocks. These dykes have been nowhere seen to pierce the Nullagine Beds.

The different formations, however, will not be described in any definite order, but a general description of the sections seen in the vicinity of the route followed will be given, as being perhaps of greater convenience.

The exigencies of the Department prevented any petrographical work in connection with the rocks of Pilbara being carried out, but a series of rocks have been sliced. As opportunity offers, it is hoped they will be microscopically examined and included in the report upon the other portion of the district yet to be examined. With this in view, a series of chemical analyses of some of the typical rocks have been made, and the result of these are given in the following table:—

Table of Analyses of Rocks from Pilbara.

Geological Museum No.	**5426**	**5395**	**5397**	**5392**	**5404**	**5384**	**5405**	**5375**
Specific Gravity	2·71	2·69	2·64	2·69	2·67	2·77	2·79	2·69
Silica, SiO_2	63·08	69·97	68·36	72·77	70·92	54·41	53·85	38·91
Alumina, Al_2O_3	15·10	18·74	18·74	13·87	12·77	12·80	14·00	1·08
Ferric Oxide, Fe_2O_3	1·72	1·04	*nil*	trace	trace	·16	·36	10·30
Ferrous Oxide, FeO	4·45	·43	1·15	2·79	4·62	10·35	8·12	1·80
Magnesia, MgO	2·67	·81	·54	·40	·33	5·72	4·51	36·65
Lime, CaO	2·83	·15	·39	1·60	1·46	5·21	6·43	trace
Soda, Na_2O	4·37	·59	10·22	4·18	3·32	3·02	3·14	·40
Potash, K_2O	3·86	5·82	·07	2·81	3·92	·02	·60	trace
Combined Water H_2O	·58	1·79	·03	·29	·54	3·42	2·94	10·89
Hygroscopic Water H_2O	·10	·05	*nil*	·02	·08	·15	·06	·28
Carbonic Anhydride CO_2	·11	*nil*	...	·24	·85	3·58	4·37	*nil*
Titanic Oxide, TiO_2	·68	·64	...	·55	·56	·78	·55	·06
Pyrites, FeS_2 Fe	·08	...	...	trace	·05	...	*nil*	*nil*
S	·09	...	...	trace	·05	...	*nil*	*nil*
Manganese Protoxide, MnO	·23	trace	·45	·22	·17	·09	·87	·08
	99·95	100·03	100·02	99·74	99·64	99·71	99·80	100·45

5426.—Granite. Mosquito Creek, Pilbara Goldfield. Analyst, J. H. Brooking.
5395.—Altered Granite (lodestuff). Boodalyerri, Pilbara Goldfield. Analyst, E. S. Simpson.
5397.—Pegmatite (tin matrix). Moolyella, Pilbara Goldfield. Analyst, E. S. Simpson.
5392.—Porphyry. Duffer's Creek, near Marble Bar, Pilbara Goldfield. Analyst, J. H. Brooking.
5404.—Quartz Felsite. Bamboo Creek, Pilbara Goldfield. Analyst, E. S. Simpson.
5384.—Andesite. North Pole, Pilbara Goldfield. Analyst, C. C. Williams.
5405.—Greenstone (dolerite). Bamboo Creek, Pilbara Goldfield. Analyst, C. C. Williams.
5375.—Serpentine. Hills near Box Soak, Pilbara Goldfield. Analyst, E. S. Simpson.

SECTION II.—TOPOGRAPHY

By far the major portion of the Pilbara Field is, as may be seen by the official maps, drained by the De Grey River and its numerous tributaries.

Some confusion having apparently arisen in respect to the nomenclature of the De Grey and its tributaries—the Davis and the Oakover—as shown on the existing maps, it may perhaps be appropriate to briefly note the facts in so far as may be ascertained by a reference to the original sources.

On the 26th of August of the year 1861, Mr. F. T. Gregory, the Commander of the North-West Australian Expedition, left his 67th camp in south latitude 21 degrees 20 minutes 13 seconds, east longitude 120 degrees 17 minutes, which lies some miles to the north-east of what is now the mining centre of Yandicoogina. This creek was traversed for 5 miles through the hills, until

> "it joined a river coming from the southward, one hundred yards wide, which was followed down on an average course of east-north-east to latitude 21 degrees 18 minutes,"[1]

where his 68th camp was pitched.

The following day, 27th August, the Commander's diary states—

> "the river took us on a northerly course nine or ten miles, receiving many large tributaries, several of them still running slightly, forming altogether a stream of some importance, which, on account of the large extent of pastoral and agricultural lands afterwards found on its banks lower down, and its many fine tributaries, I named the De Grey, in honour of the noble lord who took a lively interest in promoting the objects of the Expedition."[1]

The positions of these numbered camps are properly located upon the latest map of the State, issued by the Department of Lands, and the course of the river below delineated.

As the result of a traverse by myself down the Nullagine River from where it is crossed by the main road from Yandicoogina to the Elsie Diggings, it has been proved that the De Grey River and the Nullagine are one and the same. In view of this, having due regard to the question of priority of nomenclature, it is desirable that Gregory's name of De Grey should be retained for the whole river, from its mouth to its source.

Leaving the De Grey River on the 27th of August 1861, Commander Gregory travelled generally eastward, and on the 29th inst.

> "came upon a river 200 yards wide, running to the northward. The long drought had reduced it to a few shallow pools, running from one to the other through the deep sand in the bed."

The following day the exploring party

> "followed the river up for seven or eight miles, through fine open forest country, and encamped near a deep pool. . . . This river was named the Oakover. Camp 72."

On the 11th of September the party

> "fell back five or six miles across the ranges to a tributary of the Oakover, called the Davis;"

which was followed down to its junction with the Oakover. The position of the Davis River (of Gregory) and camp 78 is shown on the plan of the Pilbara and West Pilbara Goldfields, No. 151, issued by the Department of Mines in 1903. The same plan, however, shows another important tributary called Davis River, rising to the south of Bell Hill, lat. 22 degrees, and entering the Oakover at Carawine Pool, P 47.

On the 28th of October 1903, I visited the Oakover River at

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[1] Journals of Australian Explorations, by A. C. Gregory and F. T. Gregory, North-West Coast, 1861. Reprint, Brisbane Government Printer, 1884, pp. 78–79.

Carawine Pool, and from the summit of a high tableland on the eastern bank of the river obtained an excellent view of the valley of the Davis River (of Gregory), both up and down its course. It appears, therefore, that there are two Davis Rivers, one in the east and another in the west, entering the Oakover River above its junction with the De Grey, and it is perfectly clear that "the Davis River" flowing past Skull Spring is not identical with the Davis River as originally located by Gregory in 1861.

It may possibly be regarded as a matter of small moment what name should be given to the Nullagine and the De Grey, it being merely a question of priority of nomenclature *versus* use, but there can be no valid reason for attempting to substitute the old established name of the Davis for a new river entering the Oakover on its western side, some miles above Carawine Pool.

It is highly desirable that at any rate the principal watercourses in mining and other districts should be traversed and their position accurately laid down upon the published maps.

A very important and most marked topographical feature in the Pilbara Goldfield consists of those gorges or gaps through which practically all the rivers flow before reaching the coastal plain on their way to the sea. Wherever an opportunity was presented for examining these gorges they were found to form very narrow passes, with almost vertical walls rising to considerable heights above their base. An excellent section of one of these is shown in Fig. 5 on a later page. These gorges vary greatly in length, some giving an actual measurement of 1500 feet. Many of the watercourses, after flowing along the strike of the jaspers, &c., which invariably forms these gaps, suddenly change their course and cross the ridges at right angles. Pools of water invariably occur in the recesses of these gorges. The gaps would seem to owe their origin to the circumstance that erosion practically kept pace with the rate at which the surface of the land rose.

SECTION III.—DESCRIPTIVE GEOLOGY

A.—The Country between Port Hedland and the Shaw River

The first appearance of the granitic rocks is in the bed of Pippingarra Creek, at no great distance from Port Hedland, where they weather into the characteristic sandy soil which occupies such an extensive area between the coast and what may for convenience be called the Main Range.

In the neighbourhood of Poondana Waterhole on Petermarrer Creek, the granitic gneiss is seen to be intersected by greenstone dykes, which, wherever any sections are exposed, seem to be either vertical or inclined at high angles. Near the northern face of Poondana Hill are two vertical quartz reefs, about ten or twelve feet apart, which have a general strike of 13 degrees. The easternmost of the two rises a few feet above the surface like a wall, and is about five feet thick. The reef is traversed by horizontal and vertical joints, which cause it to break up into cubical blocks, like courses of masonry. Certain portions of the granitic gneiss rise as low bare knobs to heights about a foot or two above the general level of the surrounding country, and in one locality in the vicinity of Pippingarra numerous small crystals of tourmaline strew the surface and also occur in the country rock itself. They suggest the possibility of tin occurring in the vicinity, more especially as tin is actually being obtained from the same formation in other portions of the field.

From our camp at Box Soak, on a small creek flowing north, at a point on the (unsurveyed) road from Poondana to Lalla Rookh, almost due east of the Red Hill Trig. Station No. 10, a short traverse was made of the surrounding country, with the object of gaining a wider knowledge of its characteristics.

About a mile west of the camp, granite occupies the country as far as a low quartz ridge, the summit of which is about 140 feet by aneroid above camp. The reef has a general strike of 213 degrees, and is vertical; parallel to it on the east is another similar reef, about fifty feet distant. Neither of these two contain any minerals of commercial importance. About half a mile farther east a very conspicuous greenstone dyke, striking 18 degrees 30 minutes, and standing like a wall of masonry, can be followed across country for a considerable distance. Farther to the eastward the granite is traversed by pegmatite veins (? dykes).

The place of the granitic series is taken by schistose and other metamorphic rocks, about 200 chains from the camp. The actual width and extent of this band was not ascertainable. Near the contact between the granite and the schists, hornblende schist **[5377]**[1] makes its appearance, and sections in other portions of the neighbourhood seem to indicate that this is merely a transmuted portion of a coarse massive hornblende rock. A bed of a serpentinous rock **[5376]** of obscure origin occupies a small area near the junction of the granite with the schist; the rock is distinctly banded (? foliated), the general strike of the bands being 45 degrees; it contains crystals of felspar (?). The bands (or foliation planes) are inclined at a high angle to the east, conforming in this respect to that of the neighbouring schists. The serpentinoid rocks weather to a characteristic whitish brown colour. An analysis of a massive variety **[5375]** is shown in the table of analyses, page 7.

About five or six miles east of the Box Soak Camp is a long narrow serrated ridge, rising to a height of about 300 feet above the plains and having a general bearing of 223 degrees 30 minutes. This ridge is composed of a laminated iron-bearing jasper of the type common to many of the other goldfields of the State. The band is about 50 feet in width, and the laminæ are minutely puckered along its central portion, pointing to a movement, allied to shearing, along the trend of its outcrop. This band of jasper (chert) can be traced across country along a sinuous course for several miles. It seems quite clear that this long sinuous ridge occurs along a main line of fault. A somewhat softish banded acidic rock, containing easily recognisable felspar crystals, forms the western wall of the jasper. The eastern side of the ridge exposes a few feet of greenstone schist, which gradually gives place to gneissic granite, foliated in a direction of N. 26 degrees E., the planes of foliation being vertical.

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[1] The figures in heavy type **[5377]** throughout the report refer to the numbers of the specimens as entered in the Departmental Collection Register.

Between Box Soak Camp and Red Hill (Trig. Station 10) the country is occupied by granite, intersected by many conspicuous quartz reefs and greenstone dykes. Near the summit of Red Hill, the general bearing of these dykes is about 13 degrees. Red Hill owes its name to the characteristic reddish colour to which the rock weathers. A conspicuous quartz reef forms a bold outcrop about three-quarters of a mile east of the summit. The reef is several feet thick, and forms the summit of a serrated ridge, which can be followed across country for about two miles. The reef is vertical, and is of milkish white quartz, apparently barren. The average strike of the reef is 223 degrees. There are, in addition to a long arm of the main reef joining it on the west with an average strike of 234 degrees, two other reefs of lesser dimensions and horizontal extent, lying parallel to it on the west, but a few yards distant. They evidently all belong to the same fracture system.

Practically the whole of Pippingarra Creek drains country underlaid by granitic and allied rocks. A very conspicuous granite hill, Trig. Station 4, is traversed by a coarse greenstone dyke, trending generally 105 degrees, and of considerable horizontal dimensions, though nowhere very thick, and apparently vertical. From this point to Cook's Hill, on the south bank of the Turner River, the whole country is occupied by granite. This, however, gives place to slatey and schistose rocks at a point about 15 chains from the river bank. Cook's Hill is the crowning point of a low ridge of laterite, resting upon the upturned edges of the slatey rocks, which are traversed by veins of ironstone.

Close to Cook's Hill, and bearing from it 171 degrees, and distant about half a mile therefrom, are a series of old abandoned shafts, known as the Kobelanna workings. Those expose a series of fine-grained and almost vertical slatey rocks, striking 193 degrees, and underlying slightly to the east. So far as may be seen, the slates are traversed by thin, irregular veins of ironstone and quartz, which may have yielded a little gold to the original prospectors. The veins appear to lie along the laminæ of the slatey rocks.

About 300 chains farther up the Turner River, at Poonthanna Pool, near B 17, the channel is dammed by a bar of banded chert, which forms the conspicuous ridge on either side of the river. The pool is a fine deep sheet of water, which is apparently permanent. At the pool the section shows the bar to consist of a finely banded jasper or chert [5378], which is vertical. The central portion of the band is formed of a breccia of about 12 inches in thickness, consisting of angular fragments of the chert, recemented by quartz and oxide of iron. Horizontal faulting is also visible in the cliff section. The general strike of the ridge is 251 degrees.

About a mile to the south of B 17 the place of schists is taken by a finely foliated granite, the planes of foliation being approximately parallel to the general strike of the chert or quartzite.

Wallaringa Peak, a narrow isolated ridge rising to a height of 320 feet above the level of Poonthanna Pool, occurs in the same belt of schists. The sections exposed show the hill to be made up of decomposed vertical schists, striking 37 degrees.

There are strong stratigraphical reasons for believing that the belt of schistose rocks which cross the Turner at Kobelanna and Poonthanna Pool forms the continuation of that described as occurring to the east of the Box Soak Well. There is every reason to believe that a little gold, at any rate, may be found by carefully prospecting over the area occupied by this belt of greenstone schists and its allies.

Between Box Soak and the Strelley (?) Well, lying about south of Trig. Station No. 6, the country is underlaid by granitic gneiss of the prevailing type.

A traverse from the camp at this well, as far north as No. 6 Survey Station, over gently undulating country, demonstrated that the staple formation consisted of a rudely foliated granite, intersected by dykes (?) or veins of pegmatite.

The hill upon which Trig. Station No. 6 rests rises precipitously from the plains, and is formed of what may be called a "composite" dyke of greenstone. The dyke has an average bearing of 350 degrees, and is made up of four thin veins, each 3 feet in thickness, separated by about 10 feet of granite. To the southward these dykes coalesce and form a single vein. The rock weathers into characteristic, somewhat rounded, cubical blocks, presenting an appearance resembling courses of masonry. The vein can be followed across country for at least two miles.

Two miles distant from the hill, on a bearing of 224 degrees, is a very conspicuous knoll formed by the outcrop of a white vertical buck reef, which rises to a considerable elevation above the plain. The outcrop has an average strike of 22 deg. The ridge itself is about 10 chains in width, and is formed of a series of quartz reefs. There are two main reefs, A and B, about 10 chains apart, with several minor connecting veins. What may be called the main reef varies from 20 to 30 feet in thickness. A small, though conspicuous, hill of quartz occurs about two miles to the north, and, judging by the fragments lying on the surface, the reef thereon probably marks the continuation of the main reef described above.

From the well, last mentioned, the country as far as Lalla Rookh, at the foot of the range, is formed of granite of the usual type, and is traversed by greenstone dykes and several prominent quartz reefs.

The main road from Robinson's Hotel to Poondana traverses nothing but heavy, sandy plains, resulting from the disintegration of the granitic rocks beneath. The wells sunk for the convenience of travellers at Carlindie, the Strelley, and at Tabba Tabba (Peterson's) all derive their supplies from the zone of decomposition of the granite, which latter was met with in every case.

Lalla Rookh lies at what may be called the southern margin of the great coastal plain, which presents many of the features which characterise a plain of marine denudation. Lalla Rookh forms a small but important mining centre, which has been responsible for the production of 7602 ounces of gold during the short period of its existence. Full details as to the mines of Lalla Rookh are to be found on a later page in Part II. of this report.

In this neighbourhood the first marked important change in the geological structure of the district occurs; here there is evidence of great earth movements and powerful rupturing of the crust, as represented by a line of dislocation, proved to extend for a distance of at least 50 miles. A generalised section across this fault, or rather series of faults, is shown on the Geological Map of Lalla Rookh.

The rocks exposed in the neighbourhood of the mining centre of Lalla Rookh consist of a series of greenstone schists and their allies, intrusive diabase (dolerite?), intrusive granite, laminated ferruginous jasper, together with a series of sedimentary rocks and associated lavas.

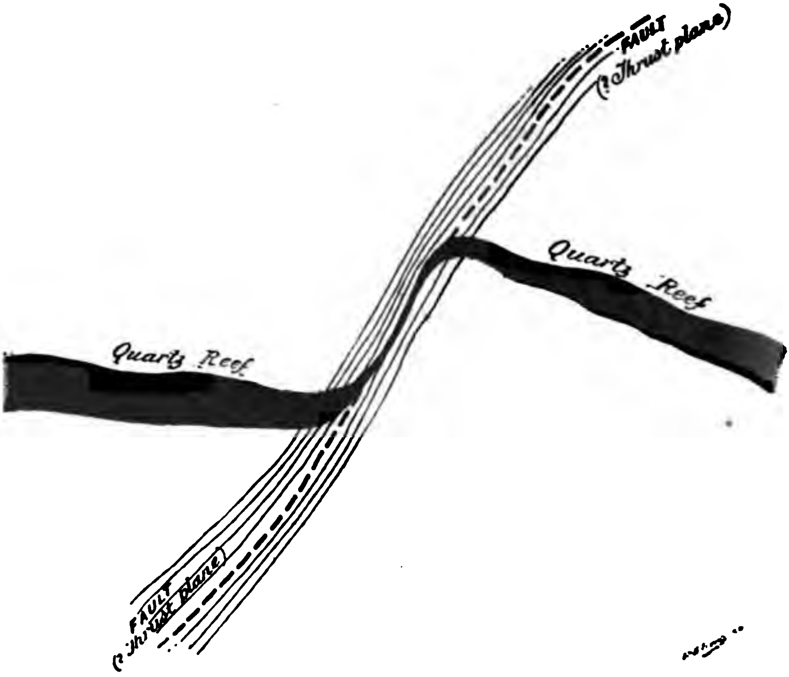
The schists occupy by far the largest area of country in the vicinity of the mines, and form the matrices of the most important of the auriferous reefs. The schists are vertical or nearly so, and seem to be arranged in a series of folds, the trend of which has been modified by the faulting which has taken place subsequent to the formation of the schists.

The quartz reefs have also been subject to the same faulting as the schists, in addition to having impressed on them structures brought about by what appears to be second foliation, which affected all rocks alike. At one spot near the face of the range, on the eastern bank of the Strelley River, an excellent section, showing the deflection of a quartz reef, is exposed, a plan of which forms Fig. 1.

This exposure occurs at but a short distance from what may be called the "main fault." The compression or shearing has been so great that this quartz reef, about 30 feet in thickness, has been reduced to from 6 to 10 inches, whilst the horizontal displacement has reached 150 feet. The quartz reef lies parallel to the lines of foliation of the schists in which it is enclosed, but a minor foliation can be detected by careful examination of country along either side of the attenuated portion of the reef.

This observation seems to indicate the occurrence of a double foliation in the district; in another portion of the Pilbara Goldfield a somewhat similar condition of affairs has been noted. In the bed of the Big Sherlock River, where it is crossed by the road from Roebourne to Mallina, distinct traces of a double foliation in the gneiss has been recorded.[1] The older and coarse banding has a north and south strike at the Big Sherlock section, and at right angles to this are a series of secondary and much finer foliations, within which it has the character of a mylonite or a fine quartz schist, perfectly distinct from the original rock.

FIG. 1.



PLAN SHEWING THE DEFLECTION OF A QUARTZ REEF STRELLEY RIVER PILBARA

A good section of the fault and the quartzite beds on either side of the mass of plicated and laminated hematite quartzite may be seen in the Strelley Gorge; the section is about 2000 yards in length, and the high cliffs afford excellent opportunities for investigating the strata.

The sketch plan and sections forming Figs. 2 and 3 show the relations of the different strata very clearly.

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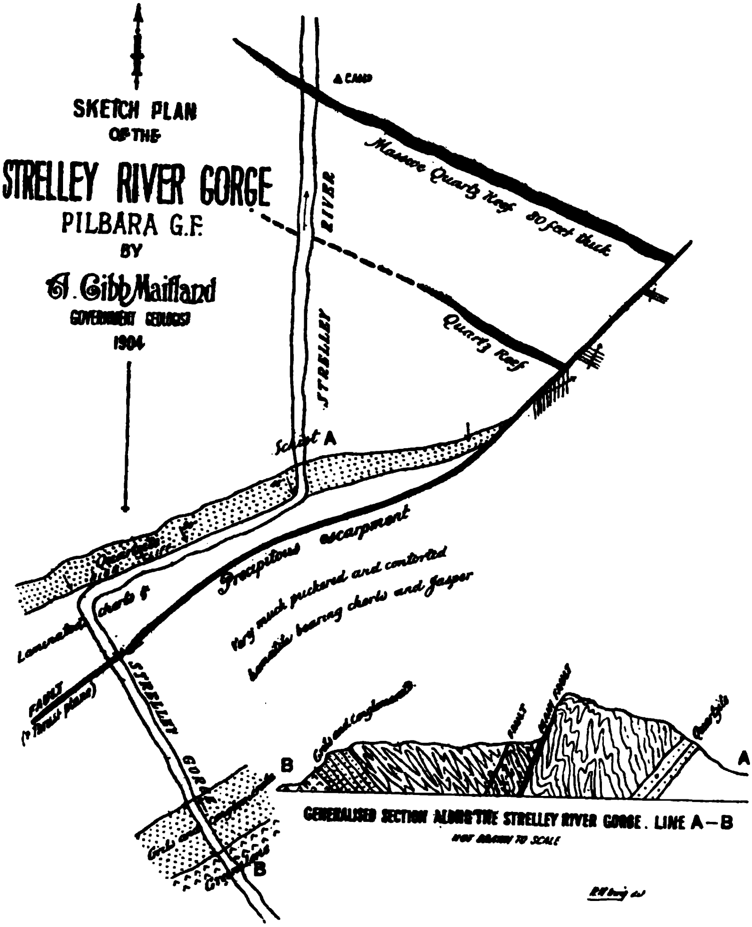
[1] "The Geological Features of the Coast of Western Australia" (H. M. Cadell), *Trans. Geol. Soc., Edin.*, 1896.

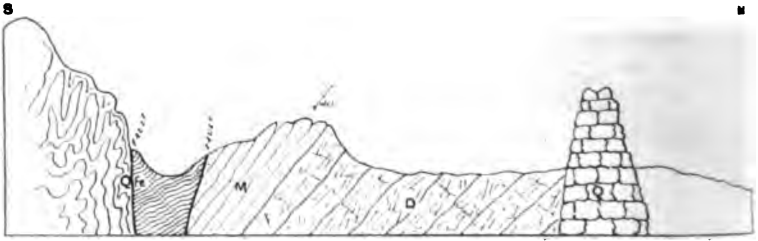
At the camp on the Strelley River, a vertical quartz reef, 80 feet in thickness, formed a gorge through which the river flowed, and presented a huge wall which could be traced across country on a bearing of south 65 degrees east. At one point this reef was abruptly truncated by the main fault. To the south of this reef is another much smaller parallel, though equally conspicuous, quartz reef, also abruptly cut off at the fault, which has an average strike of north 65 degrees east.

FIG. 2.



About 700 yards above the camp the Strelley River cuts through a bed of grit and quasi-vitreous sandstone, dipping to the south-eastward at an angle of 40 degrees, after crossing which the course of the river is deflected almost at right angles. From this point the river follows the high cliff formed by the escarpment of the sandstone bed for about 1000 yards, when its course is again deflected in a direction almost parallel to its original course. At this angle the river enters and eats its way through a gorge of about 1000 yards in length and a height of 300 feet, formed of very much puckered and contorted hematite-bearing cherts or jaspers. The southern end of the gorge exposes a section of grits [5380] and conglomerates for a length of about 220 yards, when their place is taken by diabase (?). The relation of the diabase (?) to the sedimentary beds is by no means clear; the occurrence, however, of amygdaloidal bands in one portion would seem to imply that it forms subaerial lava flow or flows. The diabase (?) appears to rise, as may be seen in the section, from beneath the sedimentary rocks, but it is more than probable that there has been an inversion of the strata, and the grits, &c., fold over the face of the lava.

FIG. 3.



Qfe = HEMATITE JASPER. M = FLAGGY QUARTZITES D = GREENSTONE (Amygdaloidal in places). Q = QUARTZ REE

SECTION NEAR THE STRELLEY RIVER GORGE PILBARA G F
NOT DRAWN TO SCALE LENGTH OF SECTION 1 MILE

Although the Strelley River section does not throw any definite light as to the relations of the unfoliated igneous rocks to the sedimentary beds, other sections—Talga Talga, Bamboo, Yandicoogina, and the Nullagine River—prove conclusively that a series of volcanic rocks are interbedded with them, and occur not far from the base of the series.

Following along the face of the range, along the line of the fault as far as Trig. Station B 27, 980 feet above sea-level, magnificent sections are displayed in several places. The greenstone schists impinge directly against the fault in the vicinity of Lalla Rookh, but at a spot about a mile and a half west of B 27, the granite which penetrates the schists abuts against the plicated hematite jaspers, and follows the line of the fracture for some distance. The junction between the two formations is a faulted one.

A traverse of the Shaw River, from my camp at B 27 to a point about 14 miles above the North Pole Diggings, showed that the country on either bank of the river is occupied for about 10 miles with those quartzites and conglomerates which occur in such great force to the south of Lalla Rookh. Numerous sections on the banks demonstrate the very much folded and faulted nature of the strata. From the summit of B 27 a bold vertical quartz reef trends generally southerly, forming an important reach of the river, and occurs along a line of fault. About 200 chains down the river from the site of the old Tremaine Mill, a section exposes the quartzite beds, abutting against the vertical schists, along a line of fault which trends generally north-east and south-west. A little distance to the south of the workings at North Pole a small patch of intrusive granite makes its appearance, but the exigencies of the work did not admit of its horizontal extent being made out. A long reach of the river, south-west from the old battery site, flows for a considerable distance over amygdaloidal lavas, which may form, as elsewhere in the district, the basal members of the Nullagine Beds. At a point about 10 miles from the battery site these give place to greenstone schists, which occupy a width, as measured at right angles to the strike, of about 300 chains. A bold, well-marked, laminated chert, trending generally east and west, and dipping south at an angle of 50 degrees, occurs in them; farther up the river these schists give place to quartzites, grits, and fine conglomerates, dipping at high angles to the south. The conglomerates contain pebbles and boulders of the cherts. The sedimentary beds are overlain in what appears, *primâ facie*, to be conformable succession, by a series of amygdaloidal lavas [5384] showing flow structure. An analysis of a typical specimen of one of these is that shown in the table on page 7; they resemble devitrified rhyolitic lavas. These volcanic rocks are faulted against the schists. A conspicuous hill of schist is traversed by a band of laminated and brecciated chert, which is steeply inclined to the west, and has an average strike of 200 degrees. This hill makes a very conspicuous feature in the landscape, and forms practically the southern extremity of the range; for, as far as the eye can see to the southwards, the country is practically an open plain, which may be underlaid by granitic and gneissic rocks. This point is about 20 miles west of Marble Bar.

From our camp on the Shaw River, in the vicinity of this locality, a traverse was made to a very remarkable chert ridge, bearing 39 degrees from camp. The ridge, which has a strike of 269 degrees, forms one of the most conspicuous features in the district; and, rising to a height of about 650 feet above the river, affords an excellent view of the surrounding country. Between the camp and the foot of the ridge the country is underlain by vesicular lava. The thickness of the chert, as measured at one spot near the summit, is about 100 feet; the central portion is very brecciated, and the fragments are recemented by secondary silica. As measured near a gap on the summit of the ridge, which is of considerable extent, the dip of the chert is 50 degrees to the south.

With the object of gaining a little knowledge of the sedimentary rocks, on the return journey to the Shaw River crossing at B 27, a detour was made to a high round-backed mountain, which reared its summit to 960 feet above the river, and from its shape I have named it Mount Hogback. The traverse, however, afforded little fresh information except that the hill consisted of grit, quartzite, conglomerate, fine sandstone [5388] and a thin bed of drab-coloured shale, faulted against the schists. Mount Hogback lies a little to the south-west of the North Pole Battery, and about 300 chains distant. The traverse up the Shaw River demonstrates that there are two distinct belts of the Nullagine Beds, separated by about 500 chains of schists and allied rocks, and in both cases the junction is marked by a vertical fault.

B.—The Country between the Shaw and the Coongan Rivers

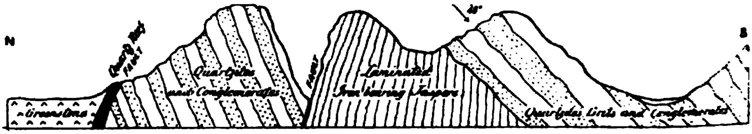
The main road from the Shaw River to Doolena Gorge on the Coongan follows closely the foot of the main range and affords many opportunities for the structure of the country being carefully examined. Cooke's Bluff Hill, on Miralga Creek (Little Shaw), is of the same formation as B 27, and has a bold quartz reef on the southern face. From this point to a creek about 8 miles from the Shaw, granite and gneiss is the staple formation.

Near what is shown as Gorge Creek Well, on the Lithograph 15 G, issued by the Department of Lands, the granite gives place to a belt of schists, which occupy a fairly extensive stretch of country in the vicinity. The general strike of the outcrop of the schists is north and south, and the beds are vertical. There are a series of jasper or chert bands associated with the schists in addition to dykes and masses of unfoliated igneous rocks.

This patch of schists is said to have yielded promising prospects of gold. Considering the identity, in the geological features, of this area with that of Lalla Rookh, it would indeed be surprising were gold not found in the vicinity.

The main range to the south, which is breached by Gorge Creek, shows the following section:—

FIG. 4.


N
Quartz Reef
Fault
Greenstone
Quartzites and Conglomerates
Fault
Laminated Iron-bearing Jaspers
40°
Quartzites Grits and Conglomerates
S

SECTION ACROSS THE RANGE AT GORGE CREEK

LENGTH OF SECTION ABOUT 20 MILES NOT DRAWN TO SCALE

Between Gorge Creek and the Coongan River, the country in the vicinity of the main road is occupied by granite or gneiss, traversed by greenstone (diabase?) dykes, which stand out in bold relief, with black weathered summits. These dykes, which form a very marked feature in this portion of the district, were evidently formed later than the general foliation of the district, and later than the powerful rupturing which the country has undergone.

The country in the vicinity of the Coongan River, near its junction with Duffer's Creek (*vide* Lands Office Lithograph G 16), shows the staple formation to be basic rocks, into which felsite dykes [5392] have intruded. An analysis of one of these is shown in the table on page 7.

A traverse to the high range due west of the mouth of the creek showed that the flats were underlaid by volcanic rocks, many beds of which are formed of agglomerate. These volcanic rocks, which are continuous with those of the neighbourhood of Talga Talga, give place to a vertical bed of jasper [3593], which rises to a considerable height above the general level of the surrounding country. The jasper contains crystals of magnetite. The general strike of the ridge is 189 degrees, and in all probability forms the continuation of the "Marble Bar," which crosses the Coongan about a couple of miles from the township. As viewed from the summit of the ridge, the country to the westward appeared to be made up of what appear to be practically horizontally bedded rocks, which in all probability represent the quartzites and conglomerates which occupy the country in the vicinity of Lalla Rookh and the Shaw River, near B 27.

C.—The Country between the Coongan and the De Grey (Nullagine) Rivers

Travelling from the Coongan River, where it is crossed by the main road at Doolena, towards Talga Talga, the country is found to be underlaid by a series of almost vertical schists, which have an average strike of north-east and south-west; the schists contain bands of ferruginous jasper of the type prevailing in other portions of the district. About a couple of miles east of Talga Talga the schists give place to granite, which occupies a considerable area of country, extending as far northward as Marble Bar, and includes within its boundaries the tin-bearing area of Moolyella. Sections in the vicinity show that the granite is intrusive, for it is seen to have insinuated itself into the schists in the form of veins, dykes, and bosses. The granite is composed of quartz, felspar, and mica, and is traversed by many north and south quartz reefs, and a series of pegmatite veins, which, when laid down upon a map, exhibit a general parallelism, and which, when viewed on the whole, conform to the strike of the quartz reefs.

The stresses and strains consequent upon the intrusion of the granite mass has resulted in the production of a series of joints, &c., which has formed the channels, up which mineral-bearing solutions have percolated, and deposited in the one place free quartz, forming the persistent reefs, and in the other have attacked the constituents of the granite. The result of this latter action is a rock [5397] made up principally of quartz, albite, a little mica, together with a few garnets and cassiterite. Considering the very large area, about 900 square miles, over which the granite has been proved to exist, with a remarkable uniformity in its structure and composition, it is by no means improbable but that careful search would result in the discovery of other portions of it quite as rich in tin as that at Moolyella.

From Moolyella to Talga Talga Soak, which lies some miles to the north-east, the whole of the country is occupied by granite of what may, for convenience, be called the tin-bearing type. At the Soak, merely a sand-well in the creek, numerous pegmatite veins occur; these are worth careful prospecting for tin ore.

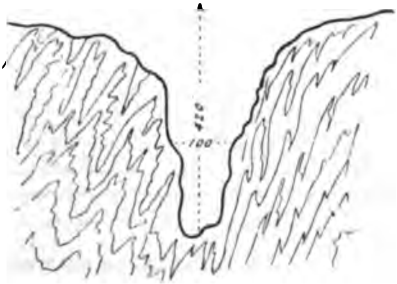
From Talga Talga Soak and bearing 260 degrees is what is called the Twin Sisters, a conspicuous ridge which forms a very prominent feature in the landscape visible for many miles around. Granite occupies the country from the Soak to the ridge, which presents a high vertical face to the east. The ridge is composed of a vertical quartz reef, from 20 to 30 feet in thickness, having an average strike of 185 degrees, agreeing very nearly in this respect with that of the quartz reefs at Moolyella. The ridge derives its name from the circumstance that it is breached by a creek, cutting the reef almost into two halves. From Talga Talga Soak to the 5-Mile Well on Reserve 8288, about 4 or 5 miles west of Bamboo Township (*vide* Mines Litho. L. 80 and Lands Litho. 15 G) is occupied by granite. This well occurs just at the western margin of a series of greenstone schists and their allies, which have been traversed by several persistent belts of laminated quartzites (? cherts) some of which attain a great thickness (one measuring 1200 feet across) and rise to considerable altitudes above the level of the surrounding country. Associated with these schists are small areas of unfoliated greenstones (diabases). Somewhat fuller details connected with these rocks are given in the second half of the report dealing with Economic Geology.

In the neighbourhood of Bamboo a series of sedimentary rocks, quartzites, grits, conglomerates and shales, together with a series of interbedded volcanic rocks, occur (Nullagine Beds). These strata, which form the north-eastern boundary of the auriferous series of Bamboo, occupy a considerable area of country, and are continuous as far as Yandicoogina on the south. So far as has been observed, the granite does not penetrate the sedimentary beds and their volcanic associates. The sedimentary rocks are bounded on the west by a powerful fault, a section of which is shown on the Geological Map of Bamboo.

While at Bamboo, opportunity was taken to examine the country to the north-west, and to this end a traverse was made to a gap (Coppins?) in the Jasper Range, some miles distant from the camp (Reserve 8288). The route followed the junction of the granite and schists and their alteration products. The gap (Fig. 5) has been carved out of a bed of laminated jasper, which, as measured in the gorge, attained a thickness of 1200 feet, and a height of 420 feet vertically above the level of the creek. The gorge is only 100 feet across from wall to wall in its widest part.

The section exposed shows that the jasper (chert?) has been violently plicated, and in certain parts faulted, the lines of fault being often filled with a fault-breccia of jasper, recemented by secondary silica. The ridge is a continuation of that at Eginbar and Doolena,[1] and is continuous as far as Bamboo, when it disappears by faulting beneath the sedimentary rocks. An excellent view of the country to the north can be obtained from the summit of the ridge, the Black Range,[1] upon which Trig. Station B 24 is situated, stands out very prominently and bears 298 degrees. The Black Range is formed of a greenstone dyke, which stands out boldly on the back of the ridge, and the series of dark, almost black, weathered rocks give the name to the Range. The dyke extends for many miles to the north-east.

FIG. 5.



SECTION ACROSS COPPINS GAP Nr BAMBOO CREEK PILBARA. G F

The country due north in the direction of the De Grey River is seen to be covered with numerous flat-topped hills, made up of those bedded rocks which form such a pronounced feature in the vicinity of Bamboo Creek, of which no doubt these beds are a continuation. To the north-west the country appears to be practically a level plain underlaid by crystalline rocks of what may be called the Lalla Rookh-Port Hedland type, described on previous pages.

The track from Bamboo to Yandicoogina crosses the auriferous series of Bamboo to the south of the Bulletin Mine, and occupies the country to a point about 4 miles north of Lyons' Well, when its place is taken by granite of the usual type. A point about 2 miles east of the well marks the boundary of the granite in this direction. From Lyons' Well to Jones' Well, about 24 miles, granite rocks prevail; these are penetrated by a few greenstone dykes. So far as may be judged by a distant view of the most conspicuous summit in the neighbourhood, Mt. Edgar, it appears as though the mountain were formed of greenstone also, possibly in the form of a boss. Some miles to the east of the track the escarpment of the Nullagine Beds could be descried, forming a kylie (boomerang) shaped continuous outcrop of what appear to be horizontally bedded rocks. The granitic rocks occupy the country to within a very short distance of the mining centre of Yandicoogina, when their place is taken by schists, which with one exception form, as elsewhere in Pilbara, the auriferous series.

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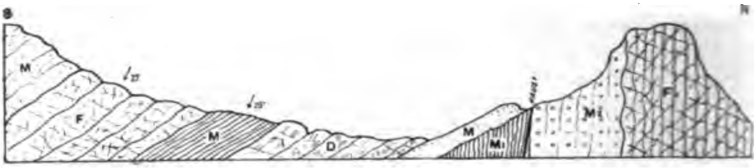
[1] *Vide* Lands Department Lithograph, G 16. Perth: By Authority, 1902.

As may be seen by an inspection of the geological sketch map of Yandicoogina, the junction between the Nullagine Beds and the schists is marked by a fault, the general trend of which is north-east and south-west.

One section in the vicinity of Yandicoogina shows beneath the grits and quartzites of the Nullagine Beds, a series of vesicular lavas. The base of this formation being concealed by a fault with a downthrow to the west, cannot be seen, hence no estimate can be formed of the total thickness of the volcanic rocks.

FIG. 6.


S
N
M
F
M
D
M
M1
M1
F1
M = COARSE CONGLOMERATE, SANDSTONE AND FISSILE SHALES.
F = FELSPAR PORPHYRY
D = AMYGDALOIDAL LAVA (?)
M1 = FELSPATHIC QUARTZITE
M2 = COARSE CONGLOMERATE.
F1 = FELSITE.
LENGTH OF SECTION ABOUT HALF A MILE
NOT DRAWN TO SCALE

SECTION AT THE ELSIE CROSSING, NULLAGINE RIVER, PILBARA G.F.

From Yandicoogina to the De Grey (Nullagine) River, at what is called the Elsie Crossing, the road trends generally south-east, following the southern escarpment of the sedimentary rocks. From beneath the sedimentary beds emerge vesicular, amygdaloidal lavas. The base of these was not noticed in any of the sections exposed within easy reach of the main road.

An instructive section is exposed in the vicinity of the crossing, and is shown in Fig. 6.

From this section it appears that there are two distinct series of sedimentary rocks, an upper, the Nullagine Beds, resting upon the upturned edges of a series of quartzites, coarse conglomerates, and felsitic lavas.

Some miles below the crossing, an island in the bed of the De Grey (Nullagine) River, shows a small thickness of sedimentary rocks, sandstones and coarse conglomerates, containing boulders of vesicular lava and felspar porphyry. The relations of this newer series to the surrounding rocks are not quite clear.

D.—The Country between the De Grey (Nullagine) and the Oakover River

At a point about 4 miles east of the Elsie Crossing, granitic rocks make their appearance from beneath the volcanic beds and occupy the surface for about 6 miles. To Mount Elsie the road is unusually rough and rugged, winding in and out as it does among the numerous gullies between the hills, and is carried over volcanic rocks and their derivatives.

The reefing centre of Elsie lies at the foot of an extremely rugged mountain from which the district takes its name and which can be seen for several miles in all possible directions.

The sections seen at intervals along the track between De Grey (Nullagine) and the Elsie seems to show that what may be called the pseudoschistose rocks are merely a dynamically altered form of volcanic rocks; it is however not clearly proven that this is the case, but if more minute investigations should demonstrate that these schists are merely transmuted volcanic rocks, an important light is thrown upon the geological features of the more southerly goldfields. Whether these igneous rocks are contemporaneous with those lying at or near the base of the Nullagine Beds remains to be proved; the impression left on the mind is that they (the schists) are of much older date. Mount Elsie is formed of schists intersected by numerous laminated iron-stained quartz reefs, with thin quartz leaders ramifying in all directions. These schists are sandwiched as it were in between two belts of limestonelike weathering schist of the type common to certain portions of the auriferous series of the north-western goldfields so far examined. A conspicuous bluff about 4 miles nearly due east of Mount Elsie, at the foot of which lies Duncan and Sullivan's gold mine, shown on the existing lithographs issued by the Government, shows a section of a decomposed felsitic lava resting upon a series of conglomerates and sandstones dipping at about 5 degrees to the south-west.

The coarse conglomerate which forms the base of the Nullagine Beds in this locality, reposes directly upon the upturned edges of the schists, and contains pebbles of granite and schist. The basal conglomerate attains a thickness of from 10 to 12 feet. The decomposed felspathic lava rises to a height of about 300 feet above its base. The summit of the bluff shows a thin bed of very fine grained chocolate-coloured sandstone, about 4 feet in thickness.

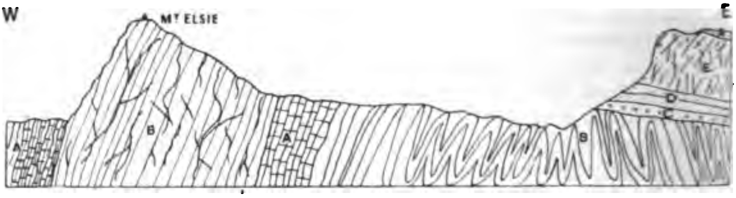
The schists beneath the Nullagine Beds in this locality are seen to be pierced by veins and dykes of granite.

Fig. 7 is a generalised section from the summit of Mount Elsie to the eastward.

The country to the east of Mount Elsie consists of a succession of low greenstone ridges. The greenstones are in many places somewhat markedly schistose and are intersected by parallel bands of laminated cherts. Associated with the schists are also patches which weather with a limestonelike character. The highest hill in the neighbourhood rises to a height of 400 feet above the surrounding country, and appears to be made up of a massive unfoliated greenstone (diabase?). One portion of it is covered with a thin bed of decomposed quartz felsite. To the south-west of this hill, the sandstones and conglomerates of the Nullagine Beds make their appearance, abutting against the greenstone by a fault. At the junction, the sandstones have a dip of 47 degrees to the west, which at some distance from the fault has flattened to 25 degrees. The sandstones are covered by a dolerite (diabasic) lava, upon which rests a bed of limestone [5419] about 15 feet thick. The limestone is covered by amygdaloidal diabase. The limestone is apparently unfossiliferous, and dips west at 20 degrees. The bed can be traced along its strike 52 degrees, for a distance of about one-and-a-half miles.

From Mount Elsie to Martin's at Boodalyerri, the country after leaving the schists is occupied by granite of the normal type.

FIG. 7.


W
MT ELSIE
E
A
B
A
B
C
D
E
A - CALCAREOUS SCHIST
B - SCHIST
C - COARSE CONGLOMERATE (Nullagine Beds)
D - SANDSTONE (Nullagine Beds;
E - FELSITIC LAVA (Nullagine Beds)
LENGTH OF SECTION ABOUT 4 MILES
NOT DRAWN TO SCALE

GEOLOGICAL SECTION OF MT ELSIE AND VICINITY

From Martin's to the Oakover, the bridle track is carried over granitic rocks for about 14 or 15 miles. The whole country is traversed by several very prominent quartz reefs, which are approximately parallel to one another. Several of these have been prospected with fair results. Considering the number of prominent reefs outcropping in the vicinity, and the rich chutes known to occur in the few that have been prospected, there is every encouragement for the prosecution of further prospecting.

Leaving what is known as the Reward Claim, a traverse was made down Boodalyerri Creek, as far as its junction with the Oakover.

Leaving the granite country about 120 chains below the head of the creek, down which the bridle track follows, a great series of what appear to be almost horizontally bedded fine-grained volcanic rocks make their appearance, and occupy the surface down to a point about 4 miles due west of Carawine Pool on the Oakover River.

Near the head of the creek a thin bed of limestone 4 to 5 feet thick, is interbedded with the volcanic rocks. The limestone, which dips at a low angle to the south 50 degrees west, rests upon amygdaloidal diabase (?), and is covered by a dense fine-grained greenstone.

Boodalyerri Creek from this point flows over a succession of amygdaloidal lava beds, to a point on the creek about 5 miles above its junction with the Oakover. Emerging from the constricted portions of the valley, the outcrop of the volcanic series can be followed for some miles to the north, and is in all probability continuous with that which forms the Ripon Hills, to the west of Gregory's 68th camp on the De Grey (Nullagine). In the year 1898, there being no officer of the Geological Survey staff available, Professor (then Mr.) R. Neil Smith, was specially employed, and during his work in this district, inquiring into the possible occurrence of artesian water between the Pilbara Goldfields and the Great Desert, gave some further particulars as to these trappean rocks. In his report this observer states:—

> Some 4 miles east of the Oakover River, and running approximately parallel with it, a prominent range rises abruptly from the surrounding alluvial plains. This consists, where inspected, of an amygdaloidal melaphyre, the exact nature of which it was impossible to determine, owing to the decomposition of the exposed rock. This range is from 200 feet to 400 feet above the bed of the river, and extends for a distance of many miles, skirting the greater portion of the eastern boundary of Warrawagine.[1]

The position of this volcanic rock is shown upon the geological sketch map which accompanies Professor Neil Smith's report. My own personal acquaintance with the country to the west of the Oakover, leaves but little doubt but that this is merely the eastern extension of the volcanic rocks traversed by Boodalyerri Creek.

At Carawine Pool, on the western bank of the Oakover River, an excellent section is seen of the limestone [5420] of the Nullagine Series. A section of this is shown in Fig. 8. The limestone [5420] is of the same lithological character as that exposed in Boodalyerri Creek, and also in the country to the west of Mount Elsie, referred to on a previous page. The thickness of the limestone in the Carawine Pool section is, as measured, not less than 300 feet. The base of the limestone is exposed on the eastern side of the Pool, on a small washaway, and seen to rest upon the beds of the volcanic series. The limestone contains bands of chert [5421] and jasper. The limestone is capped by about from 20 to 30 feet of siliceous breccia, which rests upon an uneven floor of limestone. The breccia is crowded with angular fragments of quartz and chert. This bed possibly forms the north-western extension of a mass of siliceous breccia, 300 feet in thickness, which outcrops at about 2 miles distant on the bank of the Oakover River.

The limestone forming the Nullagine Series, as exposed at Carawine, evidently covers a fairly wide extent of country, for

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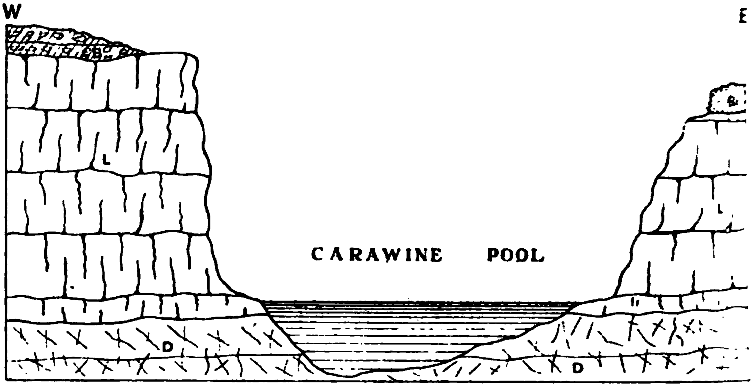
[1] The Probability of obtaining Artesian Water between the Pilbara Goldfields and the Great Desert. R. Neil Smith, Geological Survey Bulletin No. 2. Perth: By Authority 1898, p. 25.

Prof. Neil Smith, in his report previously quoted, also notes its occurrence at Tooncoonarlagee, at a point about 14 miles to the southward. This observer states that springs of water, highly charged with carbonate of lime, issue from the base of the limestone cliffs and flow into the Oakover at a rate of many thousands of gallons per day.

Fig. 8.



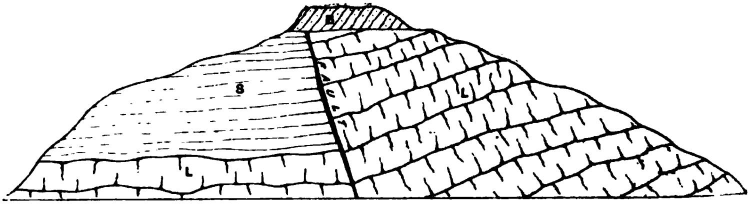
L - LIMESTONE (Nullagine Beds) D - DIABASE (DOLERITE) LAVA (Nullagine Beds) B - SILICEOUS BRECCIA. B_1 - CHALCE

SECTION AT CARAWINE POOL ON THE OAKOVER RIVER

On the eastern bank of the Oakover, at Carawine Pool, the section depicted in Fig. 9 is exposed.

The summit of the hill is formed of a small tableland of chalcedony [5423] and a white limestone [5422], the whole forming a thickness of about 20 feet. These rocks (the Oakover Beds) rest with a violent unconformability upon a dull greyish brown limestone and calcareous shale. The older limestones were folded and faulted, prior to the formation of the chalcedony capping. No fossils were detected in the limestones of either series. The base of the lower limestone series is not seen anywhere in this section.

Fig. 9.



B - CHALCEDONY L - LIMESTONE (Nullagine Beds) S - SHALE (Nullagine Beds)

SECTION ON THE EASTERN BANK OF THE OAKOVER RIVER AT CARAWINE POOL.

The upper limestone series (Oakover Beds) evidently covered a wide extent of country, for outlying mesas of it are found extending for 5 or 6 miles up Boodalyerri Creek, resting upon the volcanic beds, whilst several outliers can be seen in the country to the northwards. These isolated mesas form impressive evidence of the amount of denudation which has gone on since the formation was laid down. Describing this formation, Prof. Neil Smith, in his report previously alluded to, states:—

> Five miles south of the homestead (Warrawagine Station) a low, irregular series of limestone hills make their appearance. These hills are all of small extent, and are dotted in all directions over the strip of country between the Nullagine and Oakover Rivers. The summit of nearly every hill is, to the eye, perfectly horizontal, due to horizontal beds of limestone from denudation. The flats between these hills consist of limestone, with here and there small stretches of bow-shaped ironstone pebbles. This belt of limestone country is bounded on the east by the Oakover River, crossing it only for a very limited area 10 miles south of Braeside Station.

It is quite clear from Prof. Neil Smith's descriptions and his geological map that he did not recognise the violent unconformability between the Oakover and the Nullagine Beds.

Returning from Carawine to Mount Elsie, a traverse was made from that centre to Mosquito Creek. Two miles from Elsie the bedded volcanic rocks make their appearance and occupy the country for about 10 miles, at which point schistose rocks of the usual type emerge from beneath them and occupy the country as far as the Mosquito Diggings.

The schists in the vicinity of Mosquito are associated with a series of grits, shales, and fine conglomerates, from which, however, they could not, in the few hasty traverses I made, be satisfactorily separated, as no obvious and well-marked stratigraphical break could be detected. These beds have been invaded by granitic rocks [5425]. The schists and allied rocks continue without interruption as far as Nullagine, where they again pass beneath the strata forming the Nullagine Series.

The road from Nullagine to Marble Bar, as far as Dewhurst's Well,[1] traverses the eastern slopes of the escarpment of the sedimentary rocks of the Nullagine Series. The well, so far as may be judged by the débris round the mouth, has been sunk in sandy shale, or at any rate in fine-grained sandstone. Some little distance to the north of Dewhurst's Well, the road surmounts a bed or "sill" of porphyritic lava, not unlike that occurring at Bamboo Creek. This bed occupies the country as far as Trigonometrical Survey Station G 21, when the road descends to the sedimentary beds beneath. At Hale's Grave Well to Carbana Well the road follows the beds of the Nullagine Series, which gives place to granite of the normal type; this occupies the country as far as Corunna Downs Station, and to a point about 6 miles northwards, when schistose rocks prevail.

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[1] Lands Department Lithograph, 16 G.

PART II.—ECONOMIC GEOLOGY

SECTION I.—GENERAL

THE Pilbara Goldfield contains several gold- and tin-bearing areas, scattered over different portions of the district. Economically, the auriferous deposits have proved, up to the present, to be the most important.

The geographical position of the various mining centres, so far examined, suggests a zonal development of the auriferous deposits. So far as observations have yet been carried, it appears that the auriferous deposits of the district may be divided into four main and distinct groups, viz.: (*a*) Lalla Rookh; (*b*) Talga Talga, Bamboo; (*c*) Marble Bar, Yandicoogina, Mount Elsie; and (*d*) Mosquito, Middle Creek, Nullagine.

The length of the Lalla Rookh belt has not yet been defined, but it does not appear to be less than 30 or 40 miles; the Talga Talga–Bamboo belt, which probably includes the North Pole Diggings, is 50 miles in length; the Marble Bar–Yandicoogina belt, of which Mount Elsie is probably the continuation, has a proved extent of about 60 miles; whilst the Nullagine–Mosquito zone is known to extend for a distance of at least 40 miles. There are strong geological grounds for the belief that this latter belt continues much farther to the east, and may possibly cross the upper reaches of the Oakover River.

The general direction of these belts almost everywhere coincides with the strike of the greenstone schists, which, with two exceptions, invariably form the matrices of the auriferous reefs. The prevailing direction of the auriferous deposits, when viewed broadly, is east and west (sometimes changing to north-east and south-west), and north-west and south-east.

The width of the belt naturally varies, and in the three most northerly zones the exact width cannot be defined, owing to the fact that one of the boundaries is invariably marked by a powerful fault, which throws down the beds of the Nullagine Series against the schists and their allies.

The prevailing dip of the auriferous belts coincides with that of the enclosing schists, which is generally to the southward.

Quartz reefs occur in great abundance all through the schistose rocks, as well as to a more limited extent in the areas occupied by the granite rocks. The quartz reefs are of two distinct types, viz., white quartz reefs, and laminated quartz and jasper veins, approaching very closely the hematite-bearing quartzites (?) which invariably form a conspicuous feature in most of the goldfields of the State which have yet been examined. It is quite possible that the laminated quartz reefs are either merely silicified schists or reefs of an earlier formation which have undergone the same compression and shearing which induced the foliation of the schists. If the latter, then it is quite clear that what may be called the massive reefs are of later formation than the laminated reefs. In many cases the laminated quartz reefs are traversed by quartz veins of a later date. Some of the laminated quartz veins (quartzites) range from almost pure quartz, through banded jaspers, with crystals of magnetite, to bands appearing to the eye to be virtually pure hematite. Some of these—notably those in the Lalla Rookh zone—could be readily concentrated to high-grade ores. At present these deposits are beyond the reach of commercial enterprise, but under more favourable conditions there is little doubt but that some of them might be turned to profitable account as sources of iron ore. The quartz reefs of what may be called the massive type occur plentifully in both the schist and the granite areas, though it is only in the former that the laminated and iron-bearing quartz veins have been found, conforming in this respect to their mode of occurrence in the Southern Goldfields. The reefs invariably occur along the planes of foliation (? bedding) of the schists, or at any rate cut them at a very low angle. In some cases the reefs present characteristics which seem to indicate that they have been torn apart by movement along shear planes.

The auriferous reefs cannot be said to be long, and are as a rule small, though they occasionally swell out into large lenticular masses. Some of the reefs have been traced along the outcrop for over 2000 feet, and have swelled out to masses measuring about 15 feet across.

The value of any reef being in a large measure influenced by its richness and its quantity—by which latter is meant the thickness, length, and breadth of the shoots of gold—wherever possible, observations were made tending to throw light thereon. In no case, however, had the workings been carried sufficiently deep to enable any very reliable data being obtained as to the exact mode of occurrence of the ore shoots. In one case—the Zephyr Lease, at Talga Talga—observations were made which seemed to show that the rich ore shoots invariably occurred in the vicinity of a series of vertical fractures, traversing the reef, on a bearing of south 30–40 west. So far as may be judged from the official returns from the various properties, it appears that the shoots of gold are rich; but when the shoots got relatively poor operations ceased, for, owing to the economic conditions prevailing, only the richest ores could be worked at a profit.

The auriferous ores are, with one exception, all of such a character as render them readily amenable to battery amalgamation and cyanidation; whilst the tin ores so far examined seem to be free from those deleterious constituents which are known to occur associated with the ores of the Greenbushes Tinfield.

The following table shows the value of the mineral production of the different portions of the Pilbara Field visited and reported on up to the end of the year 1903 :—

Mining Centre.	Gold.			Tin.	
	Ore Crushed.	Gold therefrom.	Rate per Ton.	Ore Raised.	Value.
	Tons.	Ozs.	Ozs.	Tons.	£.
Bamboo Creek . . .	10,698·25	20,444·35	1·91		
Boodalyerri	106·25	1,037·05	9·76		
Elsie Creek	428·25	1,431·72	3·34		
Lalla Rookh	6,532·50	7,602·96	1·16		
Mosquito Creek . .	3,053·94	5,305·35	1·73		
Moolyella	...	...	...	855·58	56·163
North Pole	416·00	324·40	·78		
Sandy and Middle Creeks.	3,816·30	9,025·65	2·36		
Talga Talga	891·65	2,012·28	2·25		
Yandicoogina . . .	2,162·75	5,767·50	2·66		
Total . .	**28,105·89**	**52,951·26**	**1·88**	**855·58**	**56·163**

While the above table gives fairly reliable data as to the production of the reefs, the amount of alluvial gold can only be roughly approximated. The large nuggets for which the district is famed are distinctly of local origin, and are derived from the disintegration of quartz veins. From the data given in the above table it appears that the average yield per ton of ore crushed from the district alluded to has been 1·88 ozs. per ton; it is, however, unlikely that the high average of the last few years will be maintained under existing conditions. There is, however, a fair extent of low-grade ore deposits not yet developed, which under more suitable conditions, might be turned to profitable account.

The tin deposits so far worked are all of detrital origin, and have yielded considerable quantities of tin ore. Lode tin is also known to occur at Moolyella, but owing to low percentage has not yet been worked. There is every encouragement to search for richer deposits over the 900 square miles which the tin-bearing granitic rocks have been proved to extend.

Detailed descriptions of each mining centre visited are given below, and to facilitate description are accompanied by a series of geological maps, in addition to tables of statistics, taken in every case from official sources.

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SECTION II.—DESCRIPTION OF INDIVIDUAL MINING CENTRES

A.—Lalla Rookh

(*With a Geological Sketch Map and Sections, Plate II.*)

The mining centre of Lalla Rookh is situated 45 miles west of Marble Bar (the official centre of the Pilbara Goldfield), about 4 miles west of the Trigonometrical Survey Station B 27, on the Shaw River; its position is shown on the locality plan which forms the frontispiece to this report.

The field was discovered, according to the Warden's report, in the year 1899, and since that date has yielded 7,602·96 ozs. of gold, the result of the crushing of 6,532·50 tons of quartz; the average yield per ton being 1·16 ozs.

A geological sketch map, to which is attached a generalised section across the field, designed to illustrate its structural features, accompanies this report. As by far the larger portion of the area was practically a blank upon any of the existing maps, operations had to be commenced by preparing a plan of the vicinity of the mines. In the preparation of this I am under obligations to the local representatives of the British Exploration Company, who courteously placed at my disposal the lease plans in their possession, and in other ways materially facilitated the work.

Lalla Rookh lies at the foot of what may be called the Main Range, which presents a steep face to the coastward, and extends north-east and south-west for considerable distances.

The rocks of the field consist of greenstone schists and allied rocks, diabase, granite, laminated ferruginous jasper, together with a series of quartzites, grits, and conglomerates, shown on the accompanying map. The alluvial deposits form a wide strip along the banks of Lalla Rookh Creek, but they nowhere attain any great thickness.

The greenstone schists, and allied rocks, occupy by far the largest area of country in the more immediate vicinity of the mines, and it is amongst these rocks that the most important auriferous reefs yet opened up occur. The schists are vertical, or are inclined at high angles, and appear to have been arranged in a series of folds, the trend of which has been materially modified by the faulting which has taken place, subsequent to their formation. The position which these beds occupy has been delineated upon the geological map with such a degree of accuracy as the scale of the field plans would admit.

Without much more detailed work than has been possible to carry out up to the present time, it is not possible to determine whether all the "greenstone" schists are of igneous origin, or merely represent ancient sedimentary beds which have been subjected to regional metamorphism.

The schists, and allied rocks, have been invaded by dykes of diabase, the positions of which have been shown on the map. A mass of intrusive granite occupies the western margin of the field, and forms part of that extensive area which occupies the greater portion of the country between Lalla Rookh and the coast at Port Hedland. This granite is clearly of older date than that of the quartzites and other associated sedimentary beds; in no case, however, does the granite rise to the level of and pierce them.

The south-western portion of the field is occupied by a narrow strip of very much contorted ferruginous jasper and chert, which, rising with a steep vertical escarpment often over 100 feet in height, makes a very conspicuous feature in the landscape, visible for many miles.

Against these jaspideous rocks abut a series of quartzites, grits, and fine conglomerates. Owing to the faulting, &c., which has gone on in the district it is difficult to be sure of the general direction of the strike over the limited area which it was possible to examine the sedimentary rocks. The conglomerates contain pebbles and fragments of the cherts and jaspers [5387]. These beds afford no direct evidence as to their geological age, and until much more information is available their exact position in the geological time scale must be an open question. The assumption is, however, that they represent the southward extension of the strata of the King Leopold Range, Kimberley, and which are inferenially referred to the Cambrian System.

A considerable amount of faulting has gone on in the district, as may be seen by an inspection of the geological map. The boundary separating the sedimentary rocks from the jaspers, &c., is a line of fault. No attempt has been made to locate all the faults and to trace them over the ground; hence only the most prominent have been shown; to have done more than this would have required much more accurate maps than were at my command, and would have necessited much longer time being devoted to the work than was deemed called for at the time. The faulting appears to have had the effect of shifting the outcrop of one of the reefs—the Bergamina—the most pronounced, though not the most important, on the field.

The quartz of which the whole of the reefs at Lalla Rookh is composed is generally of a milk-white colour, and contains, with but one exception, very little pyrites.

THE REEFS

The following is a description of such of the mines as were open to my inspection:—

Bergamina, G.M.L. 606.—This lease is the most northerly of any yet worked at Lalla Rookh. There are four distinct reefs on the property, but only upon two of them has any serious work been done. There are two shafts on the property. The most northerly

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shaft has been sunk upon a north-and-south reef, which traverses the lease for about 400 feet north from the shaft, and which extends for a considerable distance beyond the northern boundary of the lease, but how much farther has not been determined. The reef underlays west at an angle of about 45 degrees. The reef has been opened along the outcrop for about 20 feet north from the shaft to a depth of about 8 feet; and about from 3 to 4 feet of good solid quartz is exposed. The shaft is 46 feet deep, and at the foot of the south face the thickness of the reef is 1 foot 9 inches. A drive about 37 feet in length has been carried northwards from the foot of the shaft, and the reef has been worked out to a depth of from 10 to 12 feet. The reef shows slickensided faces, pointing to a vertical movement subsequent to the formation of the deposit itself. As seen in the face of the drive, the reef attains a thickness of about 3 feet. This reef apparently peters out on the surface to the south of the shaft, and may possibly be cut off by the north-west reef in the southerly shaft. The quartz is banded, containing a little iron pyrites and free gold. Samples of my own collection [5381], assayed in the Survey Laboratory, yielded a return of 2 ozs. 2 dwts. 11 grs. of gold to the ton.

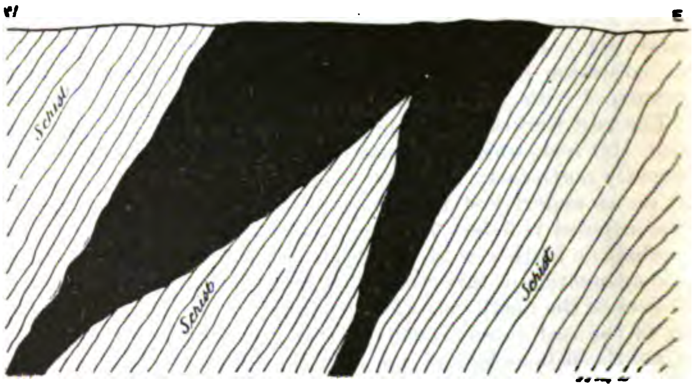
The reef worked in number (2) shaft outcrops for a distance of about 150 feet, when it appears to be cut off by a fault trending generally north-east. Number (2) shaft has been carried down 36 feet on an underlay of 45 degrees to the west, and the width of the stone exposed is 5 feet 7 inches; but beyond opening the reef in the shaft no further work has been done. What is believed to be the continuation of this reef makes its appearance at a point about 300 feet to the north-east along the line of the fault. This extension of the reef trends south-easterly for about 500 feet, as far as the southern boundary of the lease, and for a farther distance of 600 or 700 feet, when it disappears beneath the alluvial flat of Lalla Rookh Creek. The reef does not reappear on the south side of the creek, and it may be that the bold cliff which marks its outcrop on the north bank of the creek is a line of fault parallel to that which traverses the central portion of the Bergamina Lease. At one spot on its south-eastern extension the reef measures 30 feet from wall to wall. No work, however, has been done upon it.

Table showing the Yield of the Bergamina Reef.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
1902	88·00	53 00	·60
1903	98·00	48·00	·49
Total . . .	**186·00**	**101·00**	**·54**

Alma North, G.M.L. 602.—There are two reefs upon this property. The most westerly reef is situated a short distance to the east of one of the tongues of an intrusive diabase, and has an average strike of N. 40 E. A vertical shaft 18 feet deep has been sunk on the reef, but, being inaccessible at the date of my visit, no particulars are ascertainable. There was a little stone at grass. The quartz, so far as could be judged from the stone in the dump, contained small quantities of pyrites. What may be called the main reef in this property enters the lease on the north-east angle, and continues to the south with more or less regularity for a considerable distance. It has been opened up at several places, but no serious work has been done upon it. An assay of a characteristic sample [5383] from the cap of the reef yielded at the hands of the Mineralogist and Assayer a return of 1 oz. 1 dwt. 6 grs. of gold to the ton. The quartz contained a small quantity of iron pyrites in addition to bands of a siliceous oxide of iron.

FIG. 10.



SECTION ACROSS THE ALMA NORTH EXTENDED G.M.L 603 LALLA ROOKH PILBARA G F

Alma North Extended, G.M.L. 603.—The main reef traverses that half of the lease which is not covered with the modern alluvium of Lalla Rookh Creek. A shaft (*a*) has been sunk to a vertical depth of 14 feet 6 inches, and the section of the reef is as shown in the above section, Fig. 10. The thickness of the reef at the shaft is 9 feet, and as it is followed down it bifurcates, one leg being 2 feet 9 inches, and the other 1 foot thick, respectively.

Beyond sinking the shaft, no other work appears to have been done. There is a little stone lying at grass, which, on being carefully examined, contains a little iron oxide and pyrites, together with a small proportion of green carbonate of copper. At a point about 7 feet south of the shaft the reef widens out to a measured thickness of 25 feet, but it rapidly thins out as it is followed southwards.

Alma, G.M.L. 592.—The name of this lease implies that it contains the continuation of what may be called the Alma Main

Reef, which is so well developed in the property to the north, but there is no evidence to that effect, as may be seen by an inspection of the geological map of the district. The occurrence of an east-and-west fault renders such a supposition improbable, unless the north-easterly leg of the reef may be connected therewith. Near the north-west angle of the lease is a quartz reef trending 284 degrees, outcropping for a distance of over 100 feet, and which has been opened up in two places. The measured underlie of the reef is 42 degrees to the south. Near the western end of the outcrop the reef bifurcates, one branch trending to the north-east. The quartz, which is of the usual type, measures 1 foot 6 inches in thickness. No work has been done upon the reef. The country rock of this reef is a somewhat calcareous greenstone schist.

The Reward Claim, R.C. 112.—This lease is the principal one on the field, and is traversed by two fairly well-defined quartz reefs, known respectively as the North and South Reefs, in addition to others of minor importance. The western portion of the property contains a mass of intrusive diabase, the continuation of which occupies a large portion of the surface of the Kitchener Lease on the west. The greater portion of the surface of the Reward Claim is occupied by schists of the type prevailing in other portions of the field.

The plan and sections of the mine have been reduced from the drawings supplied by the owners of the property; these are reproduced on the scale of 100 feet per inch. Plate I.

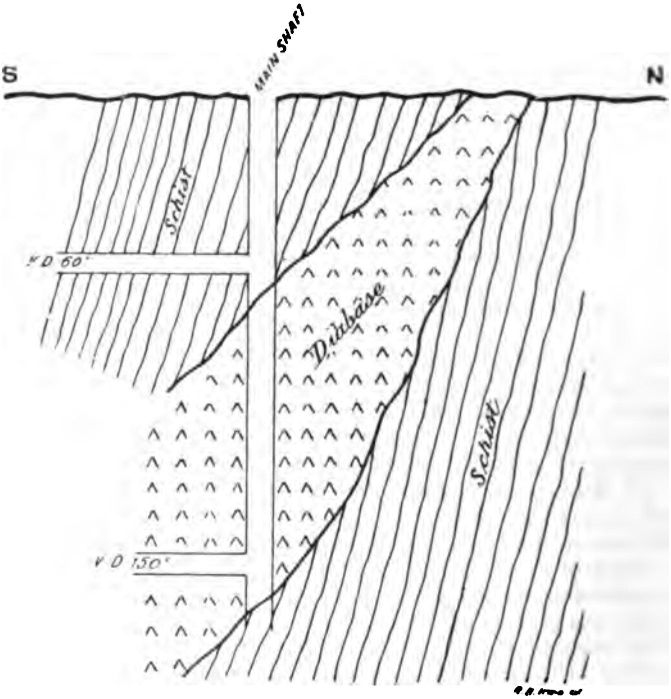
Main shaft No. 1 on the south reef had been carried down to a vertical depth of about 150 feet. In the shaft, as shown in the section, Fig. 11, the intrusive diabase, which outcrops at about 65 feet to the north, entered the shaft at 65 feet on the north, and passed out of it at 72 feet on the south side. The diabase occupied the whole shaft to a depth of about 12 feet below the level of the crosscut put in to the south at a depth of 150 feet below the surface. The country beneath the greenstone is schist of the usual type.

The crosscut at 150 feet had been carried south for a distance of 35 feet at the date the property was visited, with the object of intersecting the main south reef. The crosscut was carried through greenstone. The position of the main shaft is very near what may be called the feather-edge of the reef, *i.e.* near the eastern end of the quartz lens, and although there appears to be no sign of it outcropping, it is possible that the trend of the feather-edge underground may be to the east; in which case the crosscut would be expected to intersect it, if continued.

The question of the extension of the south reef underground at this point in a large measure depends upon the relation which the intrusive diabase bears to the fracture system which resulted in the formation of the fissures occupied by the quartz reefs. So far as the evidence of the field mapping is concerned, it appears that the south reef, as seen in the Kitchener G.M.L. 569, does not traverse the diabase. This, however, may be due to differences in the nature and texture of the two rocks; the diabase, being much more compact and tough, might not readily admit of the formation of fractures of any extent or width to the westward, as may be seen by an inspection of the geological map of the field.

One hundred and five feet to the south of the main shaft on the south reef is a main open-cut and from which an irregular quartz reef has been worked for a distance of about 100 feet along the strike and to a depth of about 20 feet below the surface. It is the reef occurring in the open-cut which the southern crosscut from No. 3 shaft on the south reef is designed to intersect.

FIG. 11.



SECTION IN MAIN SHAFT ON SOUTH REEF REWARD CLAIM 112 GML LALLA ROOKH
· PILBARA G F ·

The workings on the north reef are fully shown on the plan and sections of the mine. Some good pyritous stone, said to assay up to 30 oz. of gold to the ton, has been obtained from the reef, but at the date of my visit developments had not been carried sufficiently far to show its exact extent. A good deal of work has been done upon this reef, which has been opened up in three shafts, Nos. 1, 2, and 3, but it is only in the vicinity of shafts 1 and 2 that any ore has been stoped out. In No. 3 shaft the north reef cut out at 18 feet from the surface by a fault hading to the eastward. From the foot of the shaft, which is 30 feet deep, a crosscut has been put in to the south for a distance of 20 feet through schist of the prevailing type, and a winze has been sunk for a short distance upon a crushed or sheared zone, carrying a little quartz but no defined reef. It may be that this zone represents the continuation of the fault passed through in the shaft.

Table showing the Yield of the Lalla Rookh Reward Reefs.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
1900	700·00	2,394·85	3·42
1901	147·55	520·31	3·52
1902	3,649·00	3,116·35	·85
1903	1,781·00	1,383·05	·77
Total	6,277·55	7,414·56	1·18

Lucknow, G.M.L. 570.—The Lucknow Lease adjoins the Reward Claim on the east, and the North Reef, worked in the adjoining property, traverses the western portion of the lease.

The main shaft, near the western boundary of the lease, was, at the date of my visit, inaccessible; hence no particulars as to the nature, thickness, and behaviour of the reef could be obtained.

To the east of the main shaft is a hole down about 8 feet, showing two quartz veins, 6 and 8 inches thick respectively, separated by about 12 inches of schist. The veins, which have an average strike of about 256 degrees, are too far to the south to be the continuation of the North Reef.

Further efforts have been made to pick up the North Reef. At a point about 1000 feet east of the north-eastern angle of G.M.L. 570 is a quartz reef, about 2 feet thick, which has been opened up to a depth of about 9 feet, but beyond this no further work has been done on it. This reef is merely a lenticular vein in the schists.

About 60 feet to the east is another hole put down upon what appears to be the same line of reef to a depth of about 5 feet. This excavation exposes two quartz reefs, each about 15 inches thick, and separated by about a foot of schist with thin quartz stringers. The quartz contains a little oxide of iron, but does not prospect well.

The following synoptical table shows the output of the Lalla Rookh centre, so far as is disclosed by the official statistics. From these figures and the descriptions above given, it will be noted that the gold production of Lalla Rookh is virtually that of one mine:—

Synoptical Table showing the Yield of the Lalla Rookh Reefs.

Name of Reef, &c.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
Bergamina, G.M.L. 606 . .	186·00	101·00	·54
Kitchener, G.M.L. 569 . .	38·50	37·10	·96
Lalla Rookh, R.C. 112 . .	6,277·55	7,414·56	1·18
Sundry Claims . . .	30·45	50·30	1·65
Total . . .	6,532·50	7,602·96	1·16

B.—North Pole

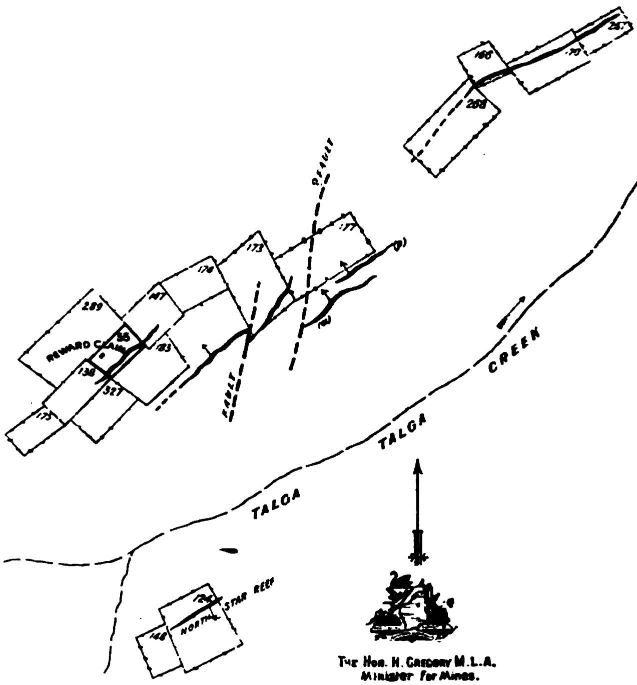
(*See Frontispiece.*)

Leaving the camp at the crossing of the Shaw River, about 4 miles from Lalla Rookh, a traverse was made as far as the now abandoned workings at North Pole. For some miles the country on either bank of the river is occupied with quartzites and conglomerates, which occur in such great force to the south of Lalla Rookh. Excellent sections in the cliffs, on the river bank, demonstrate the folded and faulted nature of the sedimentary rocks; these occupy the country almost as far as the site of the Old Battery at North Pole. A section in the vicinity shows the quartzite beds faulted against the schists and allied rocks which occupy the country in the vicinity.

The old workings are situated in some exceptionally rugged country, through which creeks run in deep, narrow gorges. The workings are situated on the flanks and summits of the ridges. The country rock of the field appears to be greenstone and its transmuted varieties.

A very conspicuous reef upon which a little work had been done runs up at the back of a razor-backed ridge, on a bearing of 71 degrees. The quartz is white in colour, and cubical cellular cavities point to the presence of pyrites in the stone. The reef is not very thick. On the summit of the hill is a peg marked 453, which probably marks the corner of the old North Democrat Lease. The reef forming the crown of the hill bears 58 degrees. About 250 feet to the west of this is another parallel and equally persistent reef. From this point we travelled generally eastward, passing numerous abandoned and inaccessible workings, and followed down a gully, which, on emerging from the range, continued its course to the Shaw River over granite country. The section exposed shows that the greenstone belt is about 3 miles wide.

PLATE 3



The Hon. H. Gregory M.L.A.
Minister for Mines.

SKETCH PLAN
SHEWING
THE AURIFEROUS QUARTZ REEFS
OF

TALGA TALGA

PILBARA G.F.

BY
A Gibb Maitland
GOVERNMENT GEOLOGIST
1903

0 10 20 30 40
SCALE OF CHAINS

EXPLANATION

QUARTZ REEFS
MINING LEASES { NAME OF .... REWARD CLAIM
MINING LEASES { No OF 55
MINING LEASES { BOUNDARIES OF ....
EXTINCT LEASES 135

A. Gibb Maitland
Government Geologist

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Writing on the 5th of September, 1898, Mr. Inspector Gladstone stated:—

> "At present only one lease is being worked, the 'Democrat,' 18 acres, the property of Messrs. Breen and party. The lease consists of part of a range of high hills, intersected with reefs and leaders, all carrying gold in greater or less quantity. About half-way up the ascent a tunnel has been driven east 250 feet. An underlay shaft sunk altogether 180 feet (inclination about 1 in 4) meets the tunnel at 150 feet, and follows the course of the reef, which consists of heavily mineralised quartz, intersected with bands of felsite. The total thickness is about 7 feet, and should give about an average of 4 feet 6 inches of clear stone. A drive has been put in 20 feet in a northerly direction from the tunnel, and at the bottom of the underlay shaft another drive south, also about 20 feet. On the crest of the range is a reef varying in thickness from 1 to 10 feet, and running east and west, on which a shaft has been sunk vertically 90 feet, and 30 feet farther east an underlay. The visible gold is apparently confined to about two chains in length of the reef, and no work has deen done beyond breaking with the hammer, but the outcrop extends for a considerable distance, and other shoots may probably be found. Just after leaving on my return journey I was told that McKenzie had discovered payable gold in an outcrop on the direct line of this reef, and distant about two miles west of the first discovery."

It appears that in 1898 a Tremaine Mill was erected on the banks of the Shaw River, near the mouth of the gully, draining the flanks of the hills upon which the principal workings were situated. The official returns shown in the following table demonstrate that very little stone could have been raised and crushed.

Synoptical Table showing the Yield of the North Pole Reefs.

Name of Reef, &c.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
North Pole Democrat, G.M.L. 453 . . .	392·00	268·00	·65
Try Again, G.M.L. 575 .	24·00	56·40	2·35
Total . . .	416·00	324·40	·78

C.—Talga Talga

(*With a Sketch Plan showing the Auriferous Reefs of Talga Talga, Plate III.*)

The mining centre of Talga Talga lies about 15 miles north of the township of Marble Bar, and three miles distant from the Talga Talga River, the position of which is shown upon the 40-chain Lithograph L 70, issued by the Department of Mines. It may be noted in passing, that although this map shows a branch telegraph line and the position of an hotel at the township of Talga Talga, neither of these exist at the present time. An important feature of the place, the Government Well, from which travellers derive their water-supply, is not located upon the plan. It is desirable that these watering places, the location of which is of the utmost importance to travellers and prospectors, should be shown upon all the published plans issued by the Government.

Writing in the year 1894, the Acting Inspector of Mines, Mr. S. J. Becher, informs the Minister for Mines that:—

> "Attention was first paid to it (Talga Talga) by dryblowers, and in times past a considerable amount of gold has been won from the gullies. During the past year a very rich creek bed has been worked adjoining the celebrated 'McPhee's Reward,' and some £2000 worth of gold has been found in the wash, occurring in the form of slugs weighing from an ounce up to 10 or 12 lbs., the larger ones carrying, in some cases, over 100 ozs. of gold; these slugs being the débris, in all probability, of past ages from the 'Reward' line of reef, in which rich chutes are being worked at the mines."[1] . . .

The Warden, in his Annual Report for 1896, states that Talga Talga yielded about 2000 ozs. of alluvial gold. There does not appear to have been any separate record kept of the yield of the alluvial gold from this centre, a circumstance which is very much to be regretted.

Talga Talga consists of a series of almost vertical schistose rocks, the general strike of which is north-east and south-west. These schists are covered with volcanic rocks on both the north and south of the workings. The exact relation of these volcanic rocks to the schists has not been satisfactorily worked out owing to the time at my disposal and the lack of adequate topographical maps. About 2 miles to the east of Talga Talga, the staple formation gives place to granite, which occupies the country as far as Duffer's Creek Well. Sections in this neighbourhood show that the granite is intrusive.

Some of the reefs of Talga Talga contain bands of a greenish-coloured quartz [5389]. This green quartz was tested in the Survey Laboratory, and five possible colouring matters were looked for, viz., the oxides of copper, ferrous iron, chromium, nickel, and vanadium. Copper and vanadium were found to be entirely absent; while strong traces of ferrous iron and chromium occurred, in addition to minute traces of nickel. From these determinations it is inferred that the green colouring is due to minute disseminated scales of either chrome chlorite (Penninite), or chrome mica, (Fuchsite).

THE REEFS

The following is a description of such of the mines as were open to inspection at the date of my visit:—

ZEPHYR LEASE (formerly known as The Reward Claim, R.C. 55), 6¼ acres.

No large scale plan of the property exists, hence detailed and intelligible description of the various workings on the lease is well-nigh impossible. The Zephyr Reef appears to be along a line of fault.

A well-defined quartz reef, underlying at 40 degrees to north 45 west, traverses the whole length of the lease, close to its south-eastern boundary. This reef has been extensively worked in previous

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[1] Report of the Department of Mines for the year 1895, Appendix 5. Perth: By Authority, 1896, p. 29.

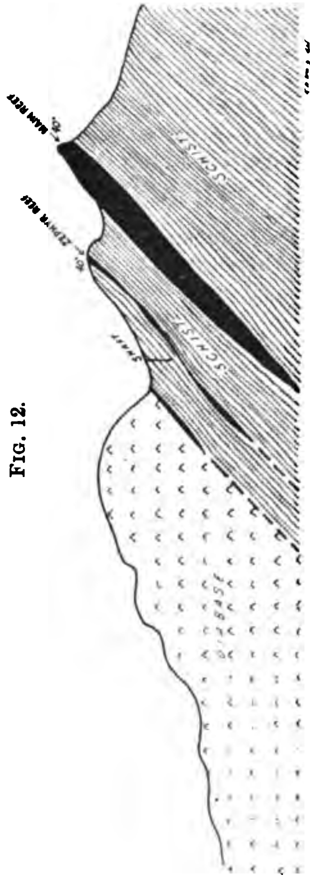

FIG. 12.

GENERALISED SECTION ACROSS THE ZEPHYR & MAIN REEFS TALGA TALGA PILBARA G.F

years by the original owners of the property. The reef occurs in schist country just near the junction of a belt of bedded greenstone which may represent a lava flow. The workings on the reef are all situated on the north-western fall of a comparatively narrow ridge, with a north-easterly trend, upon the flanks of which most of the principal auriferous reefs of Talga Talga occur. About half-way up the hillside a drive has been put in along the reef on a bearing of north 30 east for a distance of 126 feet. At 30 feet from the mouth, the reef has been followed down on the underlie for about 100 feet. As seen underground there is about an average thickness of 1 foot of quartz between the walls. The reef is traversed by a series of vertical fractures trending generally south 30–40 west. From what was shown to me underground, it is apparently along these cracks, or in the vicinity thereof, that the rich patches of gold, for which the reef is noted, occur. What was originally known as No. 1 underlay shaft was put down on a very rich shoot of stone, approximately parallel to the general trend of the fractures above alluded to, and some hundreds of ounces of gold are reported to have been dollied therefrom up to the year 1896. The stone in this underlie averaged from between 2 feet 6 inches to 3 feet in thickness. No. 2 underlay shaft had been put down for a distance of 30 feet, upon another parallel rich chute, contained in a quartz reef about 2 feet 6 inches in thickness. A vertical shaft had been put down below this second underlay shaft to cut the reef.

A vertical shaft had been put down to a depth of 120 feet, in search of water, and at 115 feet a south-eastern crosscut is said to have intersected the reef at 25 feet from the shaft. Water was met with at 50 feet, and while the quality of the water is said to be good, owing to its coming but slowly into the shaft, it cannot be said that the supply is at present sufficient for regular crushing.

When the property was in full working order in 1895 a well-equipped 10-head mill was erected. The property, however, was abandoned in 1897 by the McPhee's Reward Company, but the original prospector, Mr. Angus McPhee, returned to the scene of his original labours, and unearthed a rich leader on the ground, and, according to his own information, obtained about 500 ozs. of gold therefrom.

At the date of my visit the Zephyr Lease was held by Messrs. Anderson and Cooper, who unearthed a slug, weighing 5½ lbs., and estimated to contain a little over 30 ozs. of gold. These gentlemen had erected an ingenious crushing plant, driven by the wind as a motive power. A series of photographs were taken of the contrivance, but, unfortunately, owing to the difficulties of transit, &c., none of the negatives used on the trip proved suitable for reproduction.

The following table shows the yield of this lease, so far as can be gathered from official statistics:—

Table showing the Yield of the Zephyr Reward Reef.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
1895[1]	223	249·90[2] 666·10	1·17
1896	144	41·00	·28
	367	**957·00**	**2·68**

It appears that the official returns from this lease are credited to Reward Claim 55, but in subsequent years these are returned under the leases 147 and 148, held by the same company.

No. 1 North Reward, G.M.L. 147.—This 9-acre lease adjoins the Zephyr on the north-eastern boundary, and was originally worked by the company which held the Reward Claim (Zephyr). At the date of my visit the ground, in common with all the other properties on the field, was abandoned, and no work had evidently been carried on for some years. The Zephyr Reef enters the property on its south-western boundary, and outcrops for a short distance. A tunnel 15 feet in length had been put in to cut the reef, which was estimated to be 70 feet from the mouth. During the time this lease was held, the labour was for the most part concentrated on the Reward, hence not much work had been done. There appear to have been no crushings from this property.

Day Dawn, G.M.L. 138.—This property of 9 acres adjoins the McPhee's Reward (Zephyr) on the south-west, and operations would appear to have been confined to the Zephyr Reef, which traverses a portion of the lease. A little desultory work appears to have been done on the property, but owing to its abandonment no details are available. There appear to be no separate crushings recorded from this lease, unless such be included in the official statistics under the heading of Sundry Claims.

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[1] The original prospectors are said to have dollied several hundreds of ounces, of which no adequate record appears to have been kept.—A. G. M.

[2] Dollied.

TALGA REWARD BLOCK, G.M.L. 289.—This is a 21-acre deep level or "block" lease, originally taken for the purpose of working the Zephyr (Reward) Reef, on the dip. Practically the whole of the lease is in diabase country, and it was estimated that the Zephyr Reef would be intersected, if its dip remained uniform, at a depth of about 200 feet below the ground level. A considerable amount of trenching had been done upon a small reef, striking north-east and underlying to the south-east. This vein is said to have carried a good deal of fine gold in parts. The property has been abandoned for many years.

G.M.L. 183 (? MONTE CHRISTO).—This is a 12-acre abandoned lease, originally taken up on the main prominent quartz reef, which forms such a conspicuous feature in the landscape at Talga Talga, as shown in the generalised section across the Zephyr and Main Reef (Fig. 12). This reef, which forms the summit of the ridge, trends generally north-east and south-west, and underlies at an angle of about 40 degrees to north 55 west. The reef is traversed by two sets of rectangular joints, bearing respectively north and south and east and west. The reef, as measured in its thickest part along the mural face overlooking the creek flowing northwards into the Talga Talga River, is 24 feet thick. The quartz forming the reef is very laminated [5391], being streaked with thin bands of a very dark material, which may possibly be oxide of iron, resulting from the decomposition of fine pyrites. Cellular portions may frequently be noticed along the outcrop, which lends colour to this supposition. An assay of a characteristic sample of the stone [5391], selected without any regard to its representing an average of the reef, yielded, at the hands of Mr. E. S. Simpson, in the Departmental Laboratory, a return of 5 dwts. 8 grs. of gold to the ton. A little desultory work has been done along the outcrop, and a fair quantity of stone taken out and crushed, but the published official returns do not show any yield from this locality, unless it is included under the heading of the yield from Sundry Claims. So far as could be inferred from the condition of the outcrop workings, the ore shoot would seem to be confined to a narrow band of stone, about 2 feet thick, lying about 5 or 6 feet below the hanging wall of the reef. The distance along which the outcrop of the reef can be followed is at least 25 chains. At one point down the dip, however, the reef peters out at 90 feet from the outcrop, and its place is taken by schist of the type prevailing in the neighbourhood of Talga Talga.

MONTE CHRISTO SOUTH, G.M.L. 327.—This 9-acre lease is situated in the south-eastern angle formed by leases 138 and 183. A strong, well-defined reef, averaging about 2 feet in thickness, traverses the lease, on a general bearing of about 35 degrees, with a westerly underlie of 30 degrees. No work has been done upon the lease for many years, nor do there appear to have been any crushings recorded from it.

G.M.L. 173.—The main reef outcropping along the boundary of lease 183 continues without a break as far as the south-west angle of G.M.L. 173, at which point it is traversed by a fault trending generally north and south, with a downthrow to the east of but a few feet. From this point the reef continues without interruption through the lease, and after sweeping round the face of the ridge enters the adjoining property on the north, G.M.L. 177.

G.M.L. 177.—This property was one of the group originally held by the North-West Goldfields Company. A good deal of trenching has been done in several places along the outcrop of the reef, high up on the face of the hillside; and a tunnel, 84 feet in length, designed to intersect the main reef, is said to have passed through a small barren quartz reef at 40 feet from the mouth.

At a point (α) shown upon the sketch plan what appears to be the main reef, outcropping in G.M.L. 173, has been faulted to the southward. To the north of this reef, at a point (β) on the summit of the ridge, is the outcrop of a strong and well-defined banned quartz reef, striking north 55 east. The stone contains bands of brown hematite [5390], some attaining a thickness of about an inch. The quartz contains, in addition, small quantities of iron pyrites. This reef has been opened up along the outcrop and a little stone raised. Samples from the outcrop assayed in the official laboratory yielded but a trace of gold to the ton. There appear to have been no crushings from this property.

A group of four leases originally held by the North-West Goldfields Company lies about 20 chains north-west of the lease 177.

G.M.L. 268.—This is an 18-acre property, upon which practically no work of any moment has been done.

Reward Claim, R.C. 166.—This property comprises 6 acres, and was originally held by Messrs. Breen and Wilson, who, after doing a certain amount of prospecting work, disposed of the property to the North-West Goldfields Company. The original prospectors sank an underlie shaft, and are said to have raised about 20 tons of quartz from the reef. The Company sank an underlie shaft to a depth said to have been about 100 feet, and a tunnel 20 feet in length was put in to intersect the reef, which proved to be about 8 inches in thickness, and to have passed into calcite and dolomite (?), together with small quantities of carbonate of iron. The property appears to have been abandoned for some years, and no work of any consequence carried out.

G.M.L. 170.—This old lease of 12 acres was held by the same Company as that which held the Reward Claim, R.C. 166. Several short drives were put in on the sides of the hill facing west, where the reef outcrops, and an underlay shaft of a depth unknown put down on the reef outcroping on the summit of the hill. A water shaft of unknown depth was sunk on the flat below the hill adjoining the site chosen for a battery, but no particulars are available in connection with it. The country rock on the lease is very hard schist. A crushing of 26 tons, yielding 33 ozs. of gold, or at the rate of 1·26 ozs. per ton, has been officially recorded from this property.

G.M.L. 207.—A little desultory prospecting work has been done upon this lease, but so far nothing of any importance has resulted therefrom.

GALATEA, G.M.L. 311.—This property lies about 64 chains almost due east from the Reward Claim, R.C. 166, and its relative position may be seen by an inspection of Lithograph L. 70, issued by the Department of Mines in 1903. Four shafts have been sunk on the lease, in addition to a certain amount of trenching in different portions of the property. The principal work on the lease was concentrated on the northern end of the property. Shaft No. 1 (not shown on the map) is a large prospecting shaft reported to have been sunk to a depth of 16 feet on a large irregular quartz reef, which has an average strike of 40 deg., and a slight underlie to the north-west. The quartz lying at grass is somewhat laminated, with films and bunches of serpentine (a decomposition product of the country rock). Free gold was showing in some of the stone lying at grass at the date of my visit. No. 2 shaft had been sunk to the north to a depth of 12 feet, upon the same line of reef, but without apparently anything of any moment being found. Shaft No. 3, 12 feet deep, was sunk between two small reefs, with the object of intersecting any connecting leaders which might exist, but, being inaccessible, nothing was to be seen of the nature of the sinking. No. 4 shaft was commenced south of the main shaft on the assumed trench of the main reef, but no particulars are available. There would appear to have been no crushings from this lease, unless such be included under the heading of sundry claims shown in the official returns.

STAR OF THE NORTH, G.M.L. 124.—An 18-acre lease lying about half a mile due south of G.M.L. 183, taken up for the purpose of exploiting on E.N.E. trending reef, underlying at a comparatively low angle to the S.W. The property, long since abandoned, was originally held by the Consolidated Gold Mining Company of Western Australia. So far as may be seen at the present time, it appears that the work done upon the lease consisted of a tunnel put in along the strike of the reef, commencing at a point on the gully in which it outcrops. A winze has been put down on the underlie north-west from the tunnel, at a point 73 feet from the brace, as shown in Fig. 13.

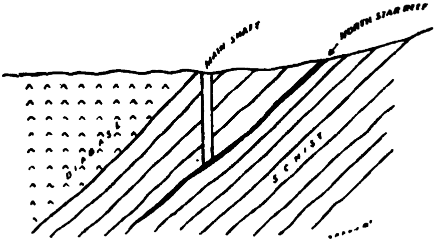
A vertical shaft has been put down 56 feet to the reef, from a point about two chains north of the outcrop of the reef. Levels have been driven a few feet east and west. The quartz is very white, is traversed by thin green veins of chlorite (?), and carries small quantities of carbonates and sulphides of copper. Flat veins of carbonate of iron are occasionally to be seen in the stone. Free gold is showing in the stone lying at grass. The following table gives the return of the crushings recorded from this mine:—

Table showing the Yield of the Star of the North Reef.

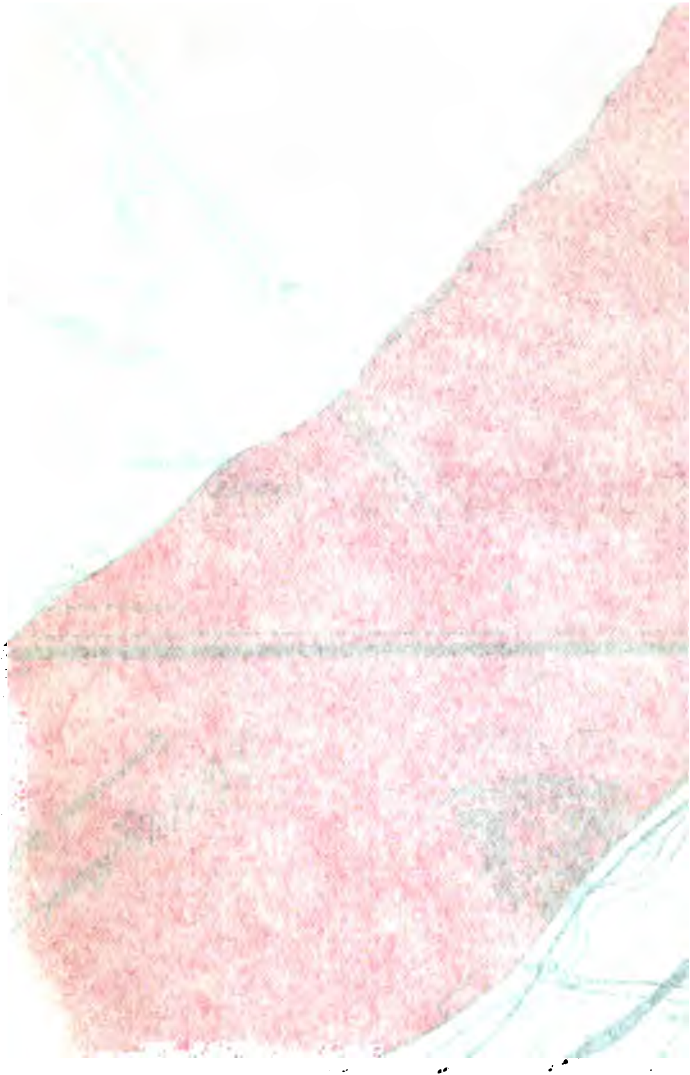
Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
Previous to 1897 . .	18·50	19·00	1·03
1897	97·00	115·74	1·19
Total . . .	**115·50**	**134·74**	**1·16**

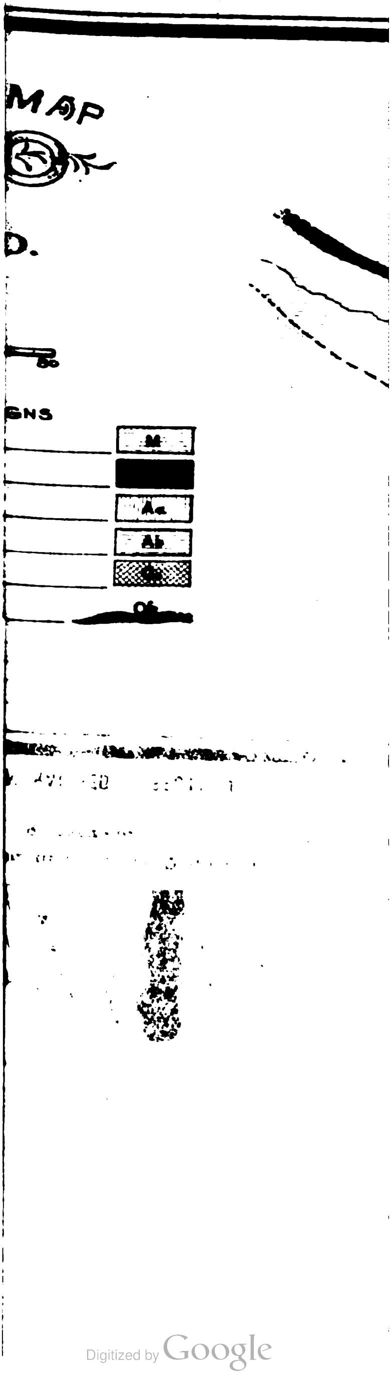
No. 1 SOUTH STAR OF THE NORTH, G.M.L. 148.—This property adjoins the one last mentioned on the west, and was originally held by the Shaw River Gold Mining Company, but has apparently been abandoned for many years. So far as may be seen at the present time, it appears that an underlie shaft of unknown depth had been put down upon a small irregular reef, striking east and west and underlying to the north. A vertical shaft 25 feet in depth had been sunk to meet the underlie, which is said to have been continued for a distance of 27 feet from the foot of the vertical shaft. A drive is stated to have been put in 17 feet to the north, but the workings being inaccessible, no particulars are available. About 10 tons of quartz from the underlie shaft and stopes are said to have been crushed and yielded a return of 2 oz. of gold per ton. It may be noted in this connection that in the Annual Mining Statistics for 1897, published by the Government, there appears a return from G.M.Ls. 147, 148 (McPhee's Reward), 367 tons yielding 957 ozs. of gold, or at the rate of 2 oz. 12 dwts. 3 grs. per ton; it is more than probable that this represents the yield from the McPhee's Reward Claim R.C. 55, now known as the Zephyr Lease.

FIG. 13.



SECTION ACROSS THE NORTH STAR REEF TALGA TALGA . PILBARA G F





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The following table shows the gold yield of Talga Talga, so far as it can be ascertained from the official statistics:—

Synoptical Table showing the Yield of the Talga Talga Reefs.

Year.	Name of Lease, &c.	Ore Crushed.	Gold therefrom.	Rate per Ton.	Total Ore Crushed.	Total Gold therefrom.	Average Rate per Ton.
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
1898	General, G.M.L. 485	43·00	44·60	1·03			
1899	,, ,,	11·50	7·90	·68	54·50	52·50	·96
1897	Jubilee, G.M.L. 458	91·00	137·00	1·50			
1898	,, ,,	33·00	45·90	1·39	124·00	182·90	1·47
evious 1897	McPhee's Reward, Ltd., G.M.L. 55 .	367·00	957·00	2·60	367·00	957·00	2·60
evious 1897	Star of the North, G.M.L. 124 . .	18·50	19·00	1·03			
1897	,, ,,	97·00	115·74	1·19	115·50	134·74	1·16
1898	N.W. Goldfields, Ltd., G.M.L. 170 . .	26·00	33 00	1·26	26·00	33·00	1·26
evious 1897	Sundry Claims .	96·00	456·00	4·75			
1899	,, ,, .	45·00	89·95	1·99			
1901	,, ,, .	9·25	24·10	2·60			
1902	,, ,, .	54·40	82·09	1.50	204·65	652·14	3·18
	Totals . .	...	...	...	891·65	2012·28	2·25

D.—Bamboo

(*With a Geological Sketch Map and Section, Plate IV.*)

The mining centre of Bamboo lies about 40 miles to the north-east of Marble Bar, and is situated on Bamboo Creek, one of the tributaries of the De Grey River. The centre is practically abandoned; at the date of my visit there existed only the post office, in charge of one officer. The office was in telephonic communication with Marble Bar.

No work of any description, except a little prospecting by four men at Nuggety Gully, was being carried on at the date of my visit, the number of abandoned workings extending continuously over a comparatively narrow strip of country for a length of a little over four miles. The abandoned shafts and other workings forcibly attest the activity which at one time prevailed at this centre. Writing in 1894, Mr. S. J. Becher, the Acting Inspector of Mines for the district, stated with reference to Bamboo Creek:—

> "Although of more recent development than Marble Bar, can boast of a large extent of workings, and a very considerable amount of systematic mining development and progress. Several individual properties have been

proved to be very valuable, and there is not a doubt that many more will yet rise above the average and come to the front. There are two batteries at work and a third is being erected. English capitalists have, during the past year, secured several groups of first-class properties, and Queensland capital has also played a part in the progress of the field. There is a healthy tone of solid work and progress about the place, which shows that its resources are good. Two hotels and several boarding-houses have crowded tables. The mail service is once a fortnight, and there is a post and telegraph office.

"Crushings from the various mines are consistently good, and the output of gold is large, considering the infancy of the field. Among the best mines may be mentioned the Bulletin, Bamboo Queen No. 1, and Mount Prophecy.

"The water-supply is obtained from wells, and seems to be abundant. Timber is very expensive, owing to the distance from which it has to be carted. The character of the country is very rugged, and the township is situated in a deep valley, through which the Bamboo Creek runs.

"The main range of granite and granitic rocks striking north-east lies a little to the east of the field, the mines and workings for the most part being on two lines or belts of 'opaline' and diorite ranges, running parallel to the main range. The backbone of one of these lesser ranges is an immense quartzite, or quartz and jasper dyke. Traces of gold have been found in this dyke, and prospecting work is being carried out thereon. The present field is about three miles long by three-quarters of a mile wide, but there is but little doubt that it will extend greatly as time goes on, especially south-eastwards towards the Little De Grey River. The auriferous quartz of the district is characteristic, and is highly mineralised with iron, copper, lead, and manganese. Calcite and carbonate of iron veins are locally considered favourable indications of gold. The reefs, taken as a whole, are small on the surface, but widen out well in depth. This is particularly well shown in the celebrated Bulletin Mine, where the lode in places widens out to 10 or 12 feet in thickness at about 60 feet in depth. The gold occurs in rich, coarse chutes, and also well disseminated throughout the stone. Like most of the other fields, Bamboo Creek owes its origin to alluvial gold finds. Much alluvial gold has been won from the gullies in the form of slugs and nuggets, as well as fine gold."[1]

Reporting upon the work of the Pilbara Goldfield in 1896, the Warden writes:—

"One of the most striking features of the present condition of mining in this field is the steady developmental work being prosecuted by private, as well as company, holders of leases. Foremost in this branch of work is that part of the Pilbara Goldfield known as Bamboo Creek, where a large amount of dead work is being undertaken."[2]

The same officer, reporting to the Minister upon the field in 1897, writes that Bamboo

"has a population of about 250. It has two hotels, two stores, Post and Telegraph Office, and a weekly mail service to Marble Bar. There are three batteries. The reefs are generally well defined, and seem to be of a permanent character. The Bulletin Proprietary Company are sinking a straight shaft on their block claim, and intend going to a depth of 500 feet to cut the Bulletin Reef. This will be the deepest shaft on the field, and will go far to prove the permanency of the reefs in this particular locality. Timber is obtained at a distance of four miles, at a cost of £2 per cord. There is good water at an average depth of 60 feet to 80 feet. The yield of gold for 1897 is 1712 ozs. out of 688 tons of stone." . . .[1]

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[1] Report of the Department of Mines for the year 1895; Appendix 5. Perth: By Authority, 1896, pp. 28–29.

[2] Report of the Department of Mines for the year 1896. Perth: By Authority, 1897, p. 59.

In his account on the prospects of the field for the following year, the Warden informs the Minister that—

> "A serious drawback to mining has been occasioned by the failure of some of the few mining companies on the field and the necessity of others to reconstruct, the cause of this being, in my opinion, the result of not providing adequate working capital. This is particularly noticeable at Bamboo Creek, where the shaft sunk on the Bulletin Proprietary Company's block has been delayed. This shaft was intended to cut the Bulletin Reef, and would have gone far towards proving the permanence of the reefs in this locality or otherwise, a test which has never yet been put to a reef on this field."[2]

The succeeding year finds the Warden writing to the Minister on the progress of Pilbara for 1899, as follows:—

> "Bamboo Creek has been under a cloud, the silver lining of which is showing, it is hoped, by the resumption of work on the Bonnie Doon, a property belonging to an English Company."[3]

In 1900 the same record of a decline at Bamboo is reported by the Warden—

> "There were only two companies (holding leases at Bamboo Creek) operating, and they did very little work, being crippled for want of capital."[4]

Since that date the field has gradually declined until, at the present time, it is practically abandoned, despite the fact that the average of the crushings from the district has been 1·91 ozs. per ton, obtained from the milling of over 10,000 tons of ore.

GENERAL GEOLOGICAL FEATURES

As may be seen by an inspection of the geological sketch map and the generalised section across the field, the auriferous series of Bamboo is contained within a narrow strip of greenstone schists and allied rocks, which flank the south-western margin of a belt of quartzites, grits, conglomerates, with interbedded felsitic lavas.

The schists, so far as can be seen in section, are everywhere practically vertical, or at any rate, inclined at high angles, and trend generally north-west and south-east. They occupy a width on the surface of about three miles, the south-western boundary being formed of granite which is clearly intrusive, for it sends out tongues and bosses into the schists. So far as mining operations have at present been carried, it appears that the auriferous reefs are confined to that portion of the schists, forming a strip not exceeding half a mile in width, and which weather into calcareous rocks [5382], which at first sight might pass for limestones.

Time did not admit of any investigations being made as to the effect of the granite intrusion upon the schists in the vicinity of the mass. Although the whole of the Archæan (?) area, as defined on the geological sketch map, is shown as consisting of schists, there are patches of unfoliated greenstones which are too small to be shown, owing to the smallness of the scale. This is particularly the case in the vicinity of the Bulletin Mine, G.M.L. 161. Here occurs a rock [5405], the composition of which is shown in the table on page 7. The rock, which is a diabase, forms the country rock of the Bulletin Reef. There seems good reason to believe that some, at any rate, of the schists are merely transmuted varieties of massive greenstones, a few patches of which occur in the vicinity. Much more detailed work than was considered expedient will be necessary before this and other cognate points can be properly investigated.

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[1] Report of the Department of Mines for the year 1897. Perth: By Authority, 1898, p. 23.
[2] Ibid., 1898. Ibid., 1899, p. 19.
[3] Ibid., 1899. Ibid., 1900, p. 105.
[4] Ibid., 1900. Ibid., 1901, p. 112.

The schists are traversed by several persistent belts of laminated quartzites (cherts ?) of great thickness, which form very conspicuous features in the landscape. The most prominent one of these measured at least 30 feet in width. It is in close proximity to these that most of the auriferous reefs yet opened up occur.

The granite occupies an extensive area of country, and is particularly well developed in the vicinity of Water Reserve 8288. Another smaller mass, about 30 chains in length and 10 in width, rises through the schists at a point about 130 chains west of the Bulletin Mine, G.M.L. 161. So far as observations have been carried in this locality, the granite does not penetrate the much newer sedimentary beds and their associated volcanic rocks; it may therefore be inferred to be of greater age than the sedimentary rocks.

The sedimentary rocks are bounded on the west by a powerful fault, which practically forms the channel in which Bamboo Creek flows. The relation of the series to the schists is diagrammatically represented in the generalised sketch section across the field accompanying the geological sketch map.

A narrow strip of quartzites, conglomerates, and shales outcrop along the bank of the river, and the relation of these to the rocks above and below them can be seen in many sections. At one point near the south-eastern boundary of the Suburban Lots area a series of almost vertical grey shales are seen to rise conformably beneath the sandstones and quartzites, which flank the northern half of the Watershed, and to be faulted against the schists and allied rocks.

Resting upon the quartzites are a series of beds of quartz felsite [5404] representing a steep, rugged face to the west, and which form an outcrop about 2 miles in width. These beds dip to the north-east at angles varying from 20 to 30 degrees. Towards the southern end of the creek the base of the lavas is about on a level with the channel, whilst the highest point to which they rise is about 150 feet. These lavas pass conformably beneath the higher quartzites, which dip at angles closely approaching 20 degrees, as shown in the section which accompanies the map.

Near the old battery site, M.A. 3, on the lower reaches of Bamboo Creek, a bed of amygdaloidal diabase (?) rises from beneath the quartzites, from which it is probably separated by a fault, occurring beneath the alluvium of the creek. Its relation to the greenstone schists and allied rocks is not clear, its dip, however, is coincident both in amount and direction with that of the sedimentary rocks.

The area this rock occupies is too small to admit of its being shown on the geological map, though it has been included in the geological section.

A large laminated quartz (chert?) vein of considerable thickness, forms the backbone of the country near the head of Bamboo Creek. The highest point of the ridge is alongside the north-eastern boundary of G.M.L. 343, and from the summit of the ridge an excellent view of the country to the north can be obtained. To the northwards the sedimentary rocks are seen to occupy the surface and to be disposed in a large synclinal trough, a conspicuous point on the north-eastern lip of the basin bearing 74 degrees, and distant, as estimated, about 8 miles.

THE REEFS

Although practically none of the mines at Bamboo were accessible at the date of my visit, the following information extracted from the manuscript reports of the Inspectors of Mines (not previously published) give some idea of the state of development and other cognate points at the time these officers visited the properties; the notes, however, make no pretentions to being more than that.

In order to facilitate description the mines are described in geographical order, commencing at the north-westernmost end of the leases. The position of the various properties is shown on the geological sketch map attached, or on Lithograph L. 80, issued by the Department of Mines.

Emily Jane, G.M.L. 192 (formerly known as the Thistle).—A shaft had been put down 30 feet to the level of the tunnel driven south-westwards from the foot of the ridge upon which the reef is situated. (**B.**)[1] There appear to have been no crushings recorded from this mine.

Alpha, G.M.L. 395.—A shaft had been sunk to an unknown depth upon the outcrop of the main Alpha Reef, and a tunnel driven about 75 feet at a point 150 feet below the outcrop, with the object of intersecting the reef at an estimated distance of 200 feet from the mouth. (**B.**) The only crushing recorded from this mine is one during the year 1899, when four tons of quartz were reported to have yielded 8·40 ozs. of gold, being at the rate of 2·10 ozs. per ton.

Princess May and Charlie, G.M.L. 407.—This 24-acre lease was originally held by the Pilbara Goldfields Company, which owned several other properties on the field. There appear to have been two reefs upon this property, known, respectively, as the Princess May and the Charlie.

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[1] The letters in heavy type throughout this portion of the report refer to the manuscript reports of (**B**) the late Mr. S. J. Becher, and (**G**) Mr. R. G. Gladstone, both of whom filled the position of Inspector of Mines at different periods.

Upon the Princess May reef, an underlay shaft was put down upon an east and west reef to the north of a tunnel, which had been driven 90 feet, the mouth of which was estimated to be about 30 or 40 feet below the level of the outcrop. The reef is said to have been at all times small but rich. The country rock is schist, which weathers into calcareous rock, locally called limestone.

Upon the Charlie reef, which had an average strike of about north-east, a shaft over 60 feet in depth had been sunk. (B.)

There would appear to have been no crushings from this property unless any such are included under the returns from Sundry Claims, details of which are not specified.

MOUNT PROPHECY, G.M.L. 46 (late G.M.Ls. 46, 49).—This is a 6-acre lease, originally held by a London Company, the Mount Prophecy and Perseverance Gold Mines, Ltd., but which appears to have been abandoned many years ago. The reef appears to have been narrow and irregular as followed down, although it was very wide in the outcrop, but despite this a good deal of work appears to have been done, and over 4000 tons of stone has been unearthed in both driving and stoping, all of which has been officially reported as returning over 2 ozs. to the ton. (G.)

The reef outcrops near the summit of a ridge, and a tunnel has been put in at about 75 feet below the outcrop; at 65 feet from the mouth the reef was met with, and was stoped up to the surface. The reef proved to be only 12 inches in width and very irregular. A winze was put down 75 feet from the end of this level upon a thin vein of quartz. A second tunnel had been put in at the base of the ridge, at a point estimated to be 180 feet below the outcrop. It was anticipated intersecting the winze above mentioned at 280 feet. A 10-head mill was erected on a machine area close to the creek, about half a mile from the workings. (B.)

So far as may be judged by the official returns, the mine has had a good record, but owing to the state of the workings it was impossible for me to ascertain anything as to the nature and behaviour of the reef underground.

The following table shows the yield of the property so far as has been officially reported:—

Table showing the Yield of the Mount Prophecy Reef.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
Previous to 1897 . .	925·00	2,350·00	2·54
1897	142·00	355·00	2·50
1898	272·00	728·50	2·67
1899	221·00	492·00	2·22
1900	97·50	147·10	1·50
Total . .	1,658·00	4,072·60	2·45

Federation, G.M.L. 169.—A 25-acre lease held by a Queensland Company, known as the Bamboo Creek G.M. Co. The reef runs about east and west, and a good deal of work would appear to have been done. A shaft had been sunk to a depth of 75 feet, and a level at that depth was driven for some distance to the north-west, following a well-defined and good hanging wall. The reef, however, is reported to have been very irregular and bunchy. (B.)

There do not appear to have been any crushings recorded unless such are included under the returns from Sundry Claims, details of which are not specified.

Bamboo Queen, G.M.L. 547 (formerly G.M.L. 409).—This property included The Reward, G.M.Ls. 49, 50, and 300. Some very rich dollying stone is said to have been taken from the outcrop of the reef by the original prospectors of the property. Besides old superficial workings a main shaft had been sunk to a depth of over 40 feet upon the Reward portion of the property, whilst the Queen portion of the property a main shaft 80 feet in vertical depth had been sunk in addition to a considerable amount of unsystematic old workings. (B.)

All the workings being inaccessible no particulars as to reefs, &c., were available. The following table gives the yield of the Bamboo Queen and Reward:—

Table showing the Yield of the Bamboo Queen Reef.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
Previous to 1897	1,170·00	2,231·00	1·90
1898	120·00	68·00	·56
1899	100·50	137·80	1·37
Total	1,390·50	2,436·80	1·75

It is not quite clear whether the yield from L.C. 131, known as Bamboo Queen, in 1903 should be included in the above return. The official figures for 1903 show that 30 tons of ore yielded 63·85 ozs. of gold, or at the average rate of 2·13 ozs. per ton.

No. 1 **South King of Timbuctoo**, G.M.L. 187.—A small lease of three acres, taken up to exploit a north-west reef having a slight underlay to the north-east. The reef is believed to be the continuation of the Queen. There appear to have been two shafts put down upon this lease—(*a*) an underlay 82 feet in depth, with a western crosscut, and (*b*) an underlay 40 feet in depth, with short drives both north and south. The reef is reported to occur in lenticular and irregular masses. The quartz is white, and said to have carried small veins of chlorite, with iron pyrites and a little galena. A 10-head mill was at one time erected on the property. (B.)

The returns from this property are included under the heading of Tasmanian and No. 1 Timbuctoo, G.M.Ls. 71 and 189, and are given in the following table:—

Table showing the Yield of the Timbuctoo No. 1 *(Tasmanian) Reef.*

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
Previous to 1897 . .	1,311·00	3,271·00	2·49
1898	122·00	131·40	1·07
Total . . .	**1,433·00**	**3,402·40**	**2·36**

Caledonia, G.M.L. 76.—A 6-acre lease, originally held by the Pilbara Goldfields Company. The reef on the property occurs into large lenticular masses, and a good deal of open-cast work appears to have been done upon it. (B.)

Hidden Treasure, G.M.L. 171.—A property at one time held by the Pilbara Syndicate, Ltd. A prospecting tunnel has been put in to test the country, but beyond the fact that it has been carried· about 100 feet, no further particulars are available. (B.)

The following table shows the returns from this property:—

Table showing the Yield of the Hidden Treasure Reef.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
Previous to 1897 . .	60·00	85·00	1·41
1898	36·00	35·00	·94
Total . . .	**96·00**	**119·00**	**1·23**

Bonnie Doon, G.M.L. 408.—The reef upon the property has an average strike of north-east with an underlay to the north at 60 degrees. This appears to be a cross line of reef to the main trend of those at present opened up on the district. A shaft had been put down on the reef to a depth of 82 feet, and a reef 6 feet in width met with. There is said to have been a considerable influx of water at the 82 feet level. The quartz of the Bonnie Doon contains a little iron pyrites, oxide of manganese, and a little talc. (B.) When examined by Mr. Inspector Gladstone, the reef then exposed was 10 feet in width. (G.) The crushing returns from this property are included with those from the other leases held by the Pilbara Goldfields Company, viz., G.M.Ls. 62, 76, 406, 408, 471, which renders it impossible to give the yield from each individual property. The following table, however, shows the yield of gold, so far as it can be ascertained from the data supplied to the Government. (B.)

Table showing the Yield of the Bonnie Doon Reef.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
Previous to 1897	829·00	1,948·00	2·35
1898	1,270·00	1,098·20	·86
1899	122·00	77·65	·63
1900	76·75	53·00	·69
Total . . .	2,297·75	3,176·85	1·81

Bamboo King, G.M.L. 471.—What was known as the Bamboo Queen workings are situated on a large reef of quartz some 10 feet wide in places, but which when followed down 30 feet petered out. Operations were eventually carried down by a tunnel put in at the base of the hill upon a good sized quartz reef 4 feet in thickness, which is said to have been of low grade, returning little more than 10 dwts. per ton. This reef was followed on the dip until it likewise petered out. (B and G.) The returns from this property are included in those of the leases 62, 76, 406, 407, 408, and 471 held by the Pilbara Goldfields, Ltd., and are given above.

Consolidated, G.M.L. 193.—An 18-acre lease owned by the Bamboo Consols Gold Mines, Limited. A tunnel has been put in for a distance of 138 feet, and is said to have intersected the reef sunk upon the adjoining underlay. At 78 feet a vertical shaft was sunk, with the object of cutting a wide lode formation showing in the tunnel, about 15 feet in width, said to be the continuation of the Bulletin Reef. (B.)

Bulletin, G.M.L. 161.—A 6-acre lease, from which 3329·50 tons have been raised and crushed up to the close of 1903, and

Table showing the Yield of the Bulletin Reef since First Worked.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
Previous to 1897	832·00	2,084·00	2·50
1897	511·50	769·00	1·50
1898	236·00	423·00	1·79
1899	530·00	724·45	1·36
1900	400·00	747·25	1·86
1901	340·00	796·90	2·34
1902	300·00	637·40	2·12
1903	180·00	180·00	1·00
Total . . .	3,329·50	6,362·00	1·93

which has yielded 6362·00 ozs. of gold, having an average grade of 1·93 ozs. per ton. No work was going on at the date of my visit, access to the workings could not be obtained, and as there do not appear to be any plans of the workings, no information as to the reef, its character, behaviour, &c., can be given.

BULLETIN DEEP LEVEL, G.M.L. 317.—This is a 24-acre "block," and a main vertical shaft has been sunk with the object of intersecting the Bulletin Reef; no particulars, however, are available, owing to the shaft being inaccessible. Mr. Inspector Gladstone reports that at the date he visited the mine the shaft had been carried down to a depth of 393 feet. (G.)

BULLETIN EAST, G.M.L. 321.—A 12-acre block, upon which two shafts have been put down. One had been put down on a reef with a slight underlay to the north. A short distance to the north of this another vertical shaft had been put down 30 feet, and a crosscut of 11 feet had been driven, but no reef had apparently been met with. (B.)

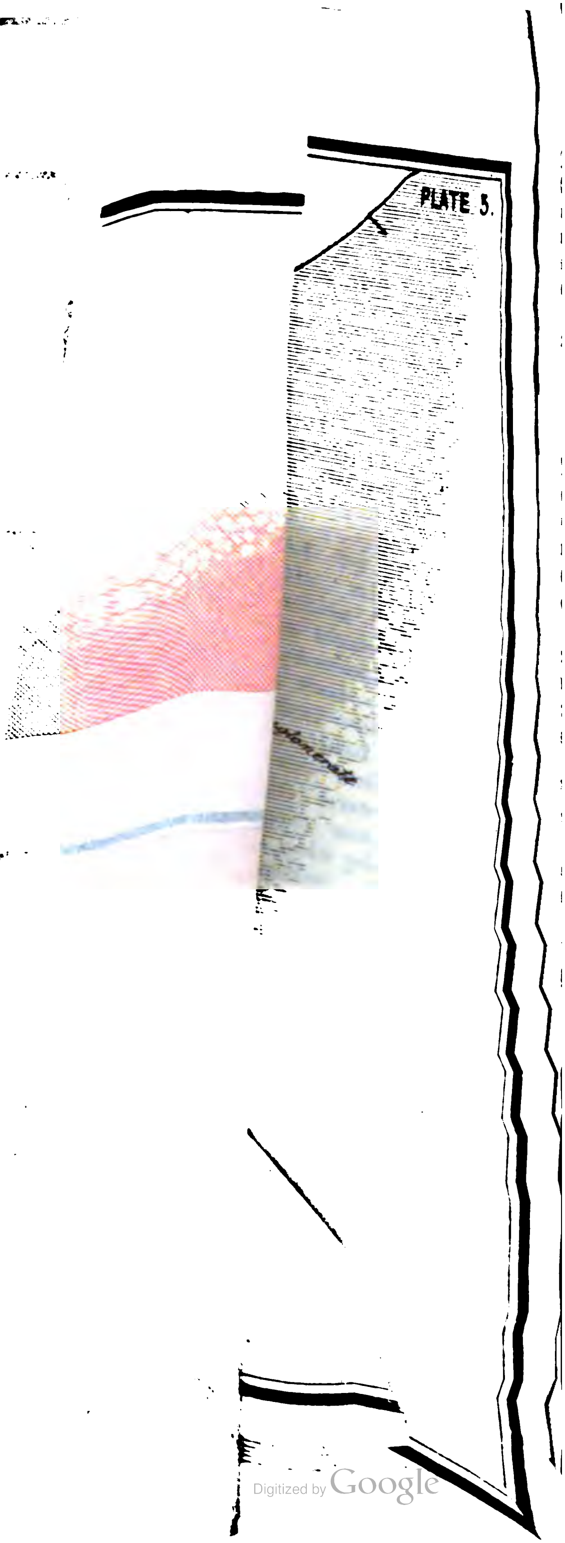
NUGGETY GULLY CLAIM.—A claim held by Messrs. Elliott, Ward, and Kale, situated on Nuggety Gully, which lies a short distance to the north-west of Widdle Waddle Creek, had been taken up a short time previous to my visit to Bamboo. An underlay shaft had been put down 25 feet by the present prospectors, on a quartz vein about 6 inches thick. At the foot of the shaft the main reef is joined by another almost vertical vein about 3 or 4 inches in thickness. The stone is auriferous, and some very rich specimens said to have been obtained from the veins were shown to me in camp. The stone contained a little iron oxide, and its facings were coated with dendritic manganese markings.

The following is a synoptical table of the gold yield of Bamboo, so far as may be gathered from official statistics. The figures are up to the end of 1903:—

Synoptical Table showing the Yield of the Bamboo Reefs.

Name of Reef, &c.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
Alpha	4·00	8·40	2·10
Bamboo Queen and Reward .	1,390·50	2,436·80	1·75
Bulletin	3,329·50	6,362·00	1·91
Mount Prophecy . . .	1,658·00	4,072·60	2·45
Nil Desperandum . . .	169·00	147·85	·87
Pilbara Goldfields, Ltd. .	2,297·75	3,176·85	1·81
Pilbara Syndicate . . .	96·00	119·00	1·23
Premier	40·00	88·00	2·20
Tasmanian	1,433·00	3,402·40	2·36
Tidal Wave	80·00	77·70	1·12
Sundry Claims . . .	136·00	438·35	4·17
Total . .	10,633·75	20,329·95	1·91

PLATE 5.



UNIV. OF MICH.

From the above descriptions, it appears that there a great deal of work done at Bamboo at one period It is, however, much to be regretted that no official s to have been kept of the state of development and points of the properties as work proceeded. To overficulty it is desirable that periodical visits be made by al staff and reports be made available to the public o time.

E.—Yandicoogina

(*With a Geological Sketch Map of Yandicoogina, Plate V.*)

Yandicoogina centre presents features which link it geowith Lalla Rookh and Bamboo Creek. The field lies miles south-east of Marble Bar and 35 miles due south of ; the relative position of the centre may be seen by a ce to the locality map attached to the earlier pages of the ; its accessibility, however, leaves very much to be desired. geological sketch map accompanies this report, and is ded to show, in a general way, the position of the different reefs heir underlie, as well as the area over which the various geoal formations extend. This map is based upon the 40-chain e map L 73, issued by the Department of Mines.

Since the first discovery of the field, Yandicoogina has yielded 76·50 ozs. of gold, resulting from the milling of 2162·75 tons of e; these figures give an average of 2·66 ozs. of gold to the ton.

The various formations represented consist of a series of schists nd allied rocks, granite, sandstones, and conglomerates, with ssociated volcanic rocks.

The junction between the sedimentary rocks and the schists is marked, as is the case at Bamboo and Lalla Rookh, by a fault, the general trend of which is north-east and south-west.

With one exception the auriferous reefs are everywhere confined to the area occupied by the schists, which however, as may be seen by an inspection of the geological map, do not occupy a very large area of country.

There are two distinct types of ore deposits on the field, viz., the white quartz reefs, and the laminated quartz (or chert) veins; these latter rise up from the surrounding country in the form of low, often serrated, ridges. The bulk of the gold, however, has been obtained from what may be called the quartz reefs of the normal type. In almost every case which came under observation the reefs of both types were parallel to the planes of foliation (? stratification) of the schists, and may, perhaps, on that account be termed bedded veins.

An impartial observer could not fail to be struck with the backward state of mining, considering the number of years which have elapsed since Yandicoogina was first opened, and the relatively high yield of the reefs as officially recorded. There is not a mine down 100 feet, and it may be said that the reefs have only been prospected, not mined.

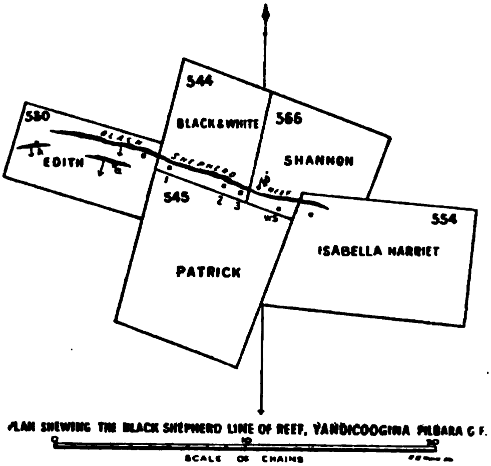
Timber, such as it is, is fairly plentiful within comparatively easy distance, and water is obtainable at a reasonable depth.

All the mines which were open to inspection were visited by me, and full descriptions are given of them in the following pages.

THE REEFS

What is known as the **Black Shepherd Reef** is the most easterly of the groups at present worked at Yandicoogina. The reef itself has been opened up in five different but adjoining leases, viz.: G.M.L. 550, Edith; G.M.L. 544, Black and White; G.M.L. 566, Shannon; G.M.L. 554, Isabella Harriet; and G.M.L. 545, Patrick.

Fig. 14.



The sketch, Fig. 14, shows the relative position of the leases and the shafts, in addition to the reefs outcropping.

The Black Shepherd Reef has a well-defined outcrop of about 1050 feet in length. It has, however, not been followed to any great depth, the deepest workings being under 60 feet below the surface. For purposes of description it will be convenient to deal with the workings on each lease separately, commencing at the western end of the outcrop.

Edith, G.M.L. 550.—There are two distinct lines of reef on this property; *b* is a small hole which has been put down upon a quartz vein 3 inches in thickness, and which underlies at an angle of 52 degrees to the south. The reef lies along the planes of foliation of the schists in which it is encased. *a* is a similar quartz reef of from 8 to 10 inches in thickness, lying parallel to the foliation planes of the schists, which in this locality have an average strike of 294 degrees. From the small fragments of quartz which strew the surface, there are good grounds for believing that the stone showing at this spot forms the continuation of the vein exposed in *b*. The main reef has been opened up by means of an open-cut for a distance of about 100 feet north-west along the outcrop, which can be followed along the surface for a distance of 350 feet farther, thus having a total proved length on this property of 450 feet; nothing can be seen, however, giving any clue as to the thickness of the reef. The reef underlies at an angle of about 40 degrees to the south. A main shaft, now disused and inaccessible, had been put down near the north-east angle of the lease with the object of intersecting the reef, but no particulars were obtainable.

During the year 1899 a crushing of 77·60 tons has been recorded as yielding 108·20 ozs. of gold, or at the rate of 1·39 ozs. to the ton.

Black and White, G.M.L. 544.—At the date of my visit the reef had been opened up along the outcrop for a distance of about 100 feet, in addition to which were three shafts, numbers 1, 2, and 3 respectively.

1. A vertical shaft, sunk about 10 or 12 feet back from the outcrop of the main Black Shepherd Reef, has been put down through country rock to a depth of 17 feet 6 inches, at which point the reef was met with. At this point the reef is represented by about 3 inches of quartz. From the foot of the vertical shaft the reef has been followed down on an underlie of 40 degrees to the south for a distance of 19 feet 6 inches. A drive has been put in 10 feet to the east, at a point on the reef 16 feet from the foot of the vertical shaft; at the face the reef is about 6 inches in thickness, though overhead in the drive it averages about 1 foot. A western drive has been put in for a distance of about 15 feet, and exposes a fair-sized body of quartz, some of the faces of which are coated with green carbonate of copper. The stone raised from this shaft is very laminated, gold showing freely in the vicinity of the seams. The quartz contains iron pyrites, copper pyrites, together with a little galena [5409]. Some of the pyrites has weathered out, leaving cubical cavities containing iron oxide, a little gold, and occasionally some free sulphur.
2. A vertical shaft, 20 feet in depth, sunk through schist to the foot wall of the reef. As seen in the workings the reef is about 12 inches in thickness, and is of the same type as that in the adjoining workings (1), of which it is a continuation.

3. A vertical shaft, 10 feet in depth to the point at which it intersects the reef, thence 44 feet down the underlie of the reef. From the foot of the shaft a drive has been put in 15 feet to the west along the reef, which varies from 7 to 8 inches in thickness. The reef occurs along the foliation planes of the schists. The present owners of the property purpose working out the stone from this level to the surface. The stone, which is identical with that above described, prospects very well.

Shannon, G.M.L. 566 (previously Black Shepherd, G.M.L. 546).—This reef has been worked by what is known as the Water Shaft (W.S.), sunk 38 feet vertically through schist country, at which point the main reef was met with. From the foot of the vertical shaft the reef has been followed on an underlie of 40 feet for a distance of about 46 feet. The reef has been worked from this point for a distance of 140 feet and stoped right out to the surface. There is about 7 or 8 feet of water standing in the shaft.

Isabella Harriet, G.M.L. 554.—The main reef continues on to this property, but the only work done is the sinking of a shaft (now inaccessible) through a fine-grained mica schist, which at the eastern end of the lease gives place to granite of the type prevailing in the district.

Table showing the Yield of the Black Shepherd Reef.

Year.	Name of Lease.	Ore Crushed.	Gold therefrom.	Rate per Ton.	Total Ore Crushed.	Total Gold therefrom.	Average Rate per Ton.
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
1899	Edith, G.M.L. 550	77·60	108·20	1·39	77·60	108·20	1·39
1898	Black and White, G.M.L. 554	17·75	48·25	2·71	192·45	487·37	2·53
1899	,, ,,	157·70	[1]396·62	2·51			
1900	,, ,,	17·00	42·50	2·50			
1898	Black Shepherd, G.M.L. 546	16·30	101·40	6·22	148·00	848·72	5·73
1899	,, ,, subsequently	117·20	732·82	6·25			
1900	Shannon, G.M.L. 566	14·50	14·50	1·00			
1899	Patrick, G.M.L. 545	34·00	144·80	4·26	215·00	572·00	2·66
1900	,, ,,	82·50	245·50	2·97			
1901	,, ,,	76·00	120·70	1·58			
1903	,, ,,	22·50	61·00	2·71			
	Total				633·08	2,016·29	3·18

[1] Includes 140·27 ozs. of dollied and specimens.

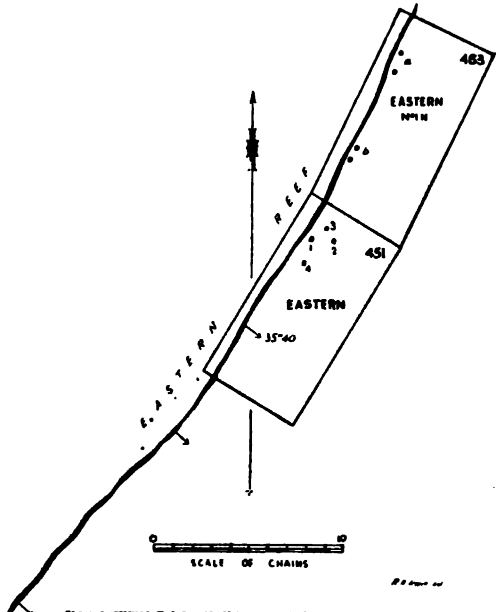
Patrick, G.M.L. 545.—No work at present being carried out. Considering the returns from the Black Shepherd Reef, it is a pity that efforts have not been made, by either boring or shaft sinking, to intersect the reef at a depth in the Patrick Lease.

From the above figures it appears that the crushings recorded since 1898 show that the average yield of the Black Shepherd Reef has been at the rate of over 3 ozs. per ton.

Eastern Reef.

The Eastern Reef lies about 60 chains to the north-west of the Black Shepherd, outcrops for about 2600 feet and has been opened up in eight or nine different localities.

Fig. 15.



PLAN SHEWING THE EASTERN LINE OF REEF YANDICOOGINA PILBARA G F

The sketch plan shows the relative position of the leases, the workings, and the outcrop of the reef, so far as it can be followed on the surface.

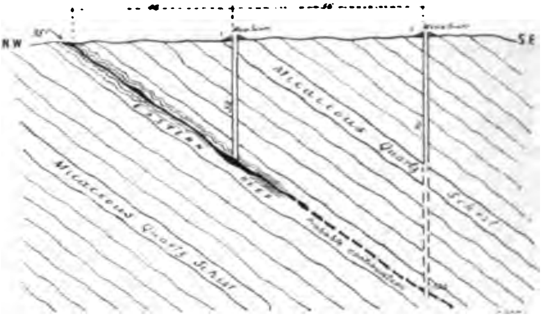
The reef is worked in two leases, viz., The Eastern G.M.L. 451, and the Eastern No. 1, G.M.L. 463. The reef has a general strike of N. 30 E., and an underlie to the south-east at angles varying from 35 to 40 degrees.

Eastern No. 1, G.M.L. 463.—The eastern reef enters the lease on the north-eastern boundary and continues without interruption across the whole length of the lease. The reef has been opened up in two separate localities (*a*) and (*b*). At (*a*) are two shafts, inaccessible at the date of my visit, sunk to the south-east of the reef, which at this point had been opened up for about 42 feet along the outcrop. At the southern end of the trench the reef is encased in the foliation planes of the schist, which forms the staple matrix of the auriferous reefs in this neighbourhood.

There is a fair quantity of stone at grass awaiting crushing. The same reef can be followed across the lease to (*b*), near the southern boundary of the property. The reef at this point has been followed for a distance of 35 feet along the outcrop, and two shafts, now quite inaccessible, were put down with the object of intersecting it at a depth. These shafts, the deepest of which is 29 feet, were sunk through decomposing micaceous schists. A crushing of 23 tons, in the year 1898, yielded 28·75 ozs. of gold, or at the rate of 1·25 ozs. per ton.

EASTERN, G.M.L. 451.—The reef enters this property at the north-east boundary, and traverses the lease from end to end without any interruption. Four shafts have been used to work the reef, viz., 1, 2, 3, and 4.

FIG. 16.



SECTION ACROSS THE EASTERN REEF G.M.L.451 YANDICOOGINA

The Main Shaft (1) has been put down 46 feet, at which point the reef was intersected, and was found to be 5 feet in thickness. From the foot of the shaft, the reef has been followed down for a distance of 35 feet on the underlie, as shown in the section, Fig. 16.

A drive 40 feet in length has been put in along the reef to the northwards from the foot of the underlie, there is, however, only an inch or two of quartz showing in the face. Southwards from the underlie the drive has been continued for about 20 feet, and at the face of the drive the reef measures 2 feet 9 inches in thickness. Shaft (2), better known as the Water Shaft, has been sunk to a depth of 70 feet through a micaceous quartz schist [5411].

At the date of my visit there was 11 feet of water standing in the shaft, and I was informed that while the shaft was being sunk, water at the rate of from 600 to 1100 gallons per hour flowed in. It is contemplated continuing this shaft, when proper pumping appliances are available, with the object of striking the Eastern Reef, which should be met with at 110 to 130 feet.

Shaft (3) is situated near the north-west angle of the lease, and has been carried down to a depth of 22 feet vertically. The reef at the foot of the shaft is 3 feet 2 inches in thickness, and is of the usual type. The reef has been worked out from this level to the surface and is said to have yielded good returns. Shaft (4), which was inaccessible at the date of my visit, had been carried down to a vertical depth of 40 feet, and showed about 3 feet of quartz, which, however, is said to have been unpayable.

The quartz [5410] contains a little iron pyrites, galena, together with small quantities of green and blue carbonates of copper. A good deal of free gold is showing in the stone at grass, of which there is estimated to be about 200 tons. There has been no crushing for about 2 years. From the fact that some of the stone in the eastern reef is slickensided it would seem that considerable movement has taken place since the formation of the reef, an observation which is confirmed by the occurrence of violently contorted and puckered "formation" (crushed rock) between the walls. Work has hardly been carried on sufficiently far for any observations as to the trend of the ore chutes to be definitely made out. Between the years 1898 and 1903, there have been crushed from this lease 665·85 tons of quartz, recorded as yielding 777·55 ozs. of gold, thus averaging 1·17 ozs. to the ton.

The Eastern Reef can be followed for a distance of 1100 feet along the outcrop, from the south-eastern boundary of G.M.L. 451.

The following table shows the yield of the Eastern Reef, as shown by official data:—

Table showing the Yield of the Eastern Reef.

Year.	Name of Lease.	Ore Crushed.	Gold therefrom.	Rate per Ton.	Total Ore Crushed.	Total Gold therefrom.	Average Rate per Ton.
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
1898	Eastern No. 1, G.M.L. 463	23·00	28·75	1·25	23·00	28·75	1·25
1898	Eastern, G.M.L. 451 .	114·00	154·40	1·35			
1899	,, ...	359·85	398·05	1·10			
1900	,, ...	22·50	31·75	1·41			
1901	,, ...	35·50	51·60	1·45			
1902	,, ...	*Nil.*	*Nil.*	*Nil.*			
1903	,, ...	111·00	113·00	1·02	642·85	748·80	1·16
	Total . .	...	...	...	665·85	777·55	1·17

LADY ADELAIDE REEF.

The Lady Adelaide Reef lies about 60 chains south-west from the Eastern Reef, and the outcrop is parallel thereto. It is possible, however, that the two are one and the same reef, although the quartz [5413] differs somewhat from that of the Eastern. The reef can be followed along the surface for about 2000 feet.

LADY ADELAIDE, G.M.L. 49.—No work was going on at the date of my visit. A main shaft had been put down to a vertical depth of 60 feet, and is said to have passed through the reef at 15 feet. A drive about 70 feet in length has been put in in a south-easterly direction from the foot of the shaft, and another of 20 feet to the north-west; both, however, are now full of water, which reaches to a height of 9 feet from the bottom of the shaft.

The Lady Adelaide Reef has been opened up along the surface for a considerable distance northwards, but very little work appears to have been done, as is borne out by the records of crushing shown in the table.

Table showing the Yield of the Lady Adelaide Reef.

Year.	Name of Lease.	Ore Crushed.	Gold therefrom.	Rate per Ton.
		Tons.	Ozs.	Ozs.
1898	Lady Adelaide No. 1, G.M.L. 562	35·25	62·80	1·78
1899	,, ,,	20·00	22·50	1·12
1900	,, ,,	*Nil*		
1901	,, ,,	6·00	3·00	·50
	Total . .	61·25	88·30	1·44

UNCLE TOM REEF.

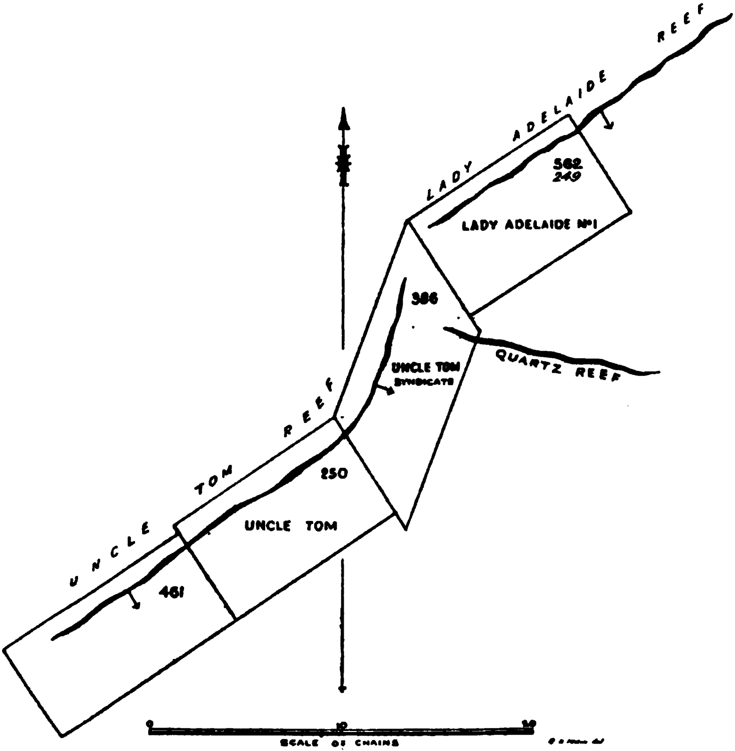
The Uncle Tom Reef traverses three properties: Cyclone, G.M.L. 386; Uncle Tom, G.M.L. 250; and Uncle Tom West, G.M.L. 461.

CYCLONE, G.M.L. 386.—A fairly well-defined quartz reef, having an average bearing of 25 degrees 30 minutes, has been opened up along its outcrop for about 130 feet. The workings are inaccessible, hence nothing could be seen. There do not appear to have been any crushings recorded from this property. This reef can be followed with scarcely any interruption south-westerly into the adjoining lease—the Uncle Tom.

UNCLE TOM, G.M.L. 250.—A good strong reef, forming the summit of a fairly conspicuous ridge, outcrops on a bearing of 63 degrees, and has been, so far as may be judged by the condition of the surface, extensively worked. The workings, however, are inaccessible, hence nothing can be seen as to the behaviour of the reef underground. So far as may be seen by the material at grass, the reef occurs in schist country.

The following plan shows the relative positions of the Lady Adelaide and the Uncle Tom Reefs:—

FIG. 17.



PLAN SHEWING THE POSITION OF THE LADY ADELAIDE AND UNCLE TOM REEFS YANDICOOGINA.

A parallel reef outcrops on a bearing of 56 degrees, and is situated 33 feet north of this main reef. This reef has been worked to some extent. A shaft, 62 feet from the north-west angle of the lease, on a bearing of 276 degrees, has been carried down 29 feet vertically. The reef measures 3 feet between the walls. The quartz [5415] from the reef contains large quantities of massive iron pyrites, often in pieces of large size, a little galena, and, in much smaller proportions, zinc blende.

An east and west reef, which may have some connection with the main quartz reef, enters the lease at the north-east angle of the ground, and can be followed eastwards for about 900 feet.

The following table gives the total gold yield of the Uncle Tom line of reef :—

Table showing the Yield of the Uncle Tom Reef.

Year.	Name of Lease.	Ore Crushed.	Gold therefrom.	Rate per Ton.	Total Ore Crushed.	Total Gold therefrom.	Average Rate per Ton.
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
1898	Uncle Tom, G.M.L. 494	100·00	440·00	4·40			
1899	,, ,,	46·50	218·41	4·69			
1900	,, ,,	130·70	251·25	1·92			
1901	,, ,,	27·00	76·75	2·84	382·20	1,299·71	3·24
1903	,, ,,	78·00	313·30				
1899	Uncle Tom West, G.M.L. 461 . .	83·85	146·75	1·75			
1900	,, ,,	15·00	24·00	1·60			
1901	,, ,,	47·00	82·75	1·76	145·85	253·50	1·73
	Total . .	...	...	...	528·05	1553·21	2·74

AUNT SALLY REEF.

A quartz reef, from which two small crushings have been recorded, has been worked on G.M.L. 495, but being abandoned and at the present time wholly inaccessible, no description of either the nature of the reef or its behaviour underground can be given. It is conceivable that the Aunt Sally Reef is the continuation of that east and west reef which enters the Uncle Tom, G.M.L. 386, at its north-west angle. If this be so, then it appears probable that a certain amount of longitudinal movement had taken place along the line of the Uncle Tom and Lady Adelaide Reefs, and has had the effect of dislocating the Aunt Sally Reef. The yield of this reef is shown in the following return :—

Table showing the Yield of the Aunt Sally Reef.

Year.	Name of Lease.	Ore Crushed.	Gold therefrom.	Rate per Ton.
		Tons.	Ozs.	Ozs.
1898	Aunt Sally, G.M.L. 495 . .	13·50	12·75	·94
1899	,, ,, . .	13·50	8·25	·61
	Total . .	27·00	21·00	·78

TRILBY REEF.

Another reef, the Trilby, which may represent a continuation of the Uncle Tom Reef, has been worked in the G.M.L. 396, on the western bank of one of the important tributaries of Yandicoogina Creek. The reef occurs in the belt of schist, which traverses the whole length of the productive area of the field. The property was abandoned, and the workings inaccessible, hence no details as to the character and dimensions of the reef were obtainable. As may be seen by the table attached, there have been two small crushings recorded, one averaging two and three-quarter ounces of gold to the ton, and the other nearly three and a half ounces.

Table showing the Yield of the Trilby Reef.

Year.	Name of Lease.	Ore Crushed.	Gold therefrom.	Rate per Ton.
		Tons.	Ozs.	Ozs.
1898	Trilby, G.M.L. 396 . .	35·25	122·80	3 48
1899	,, ,, . .	30·75	84·70	2·75
	Total . .	66·00	207·50	3·14

INVINCIBLE REEF.

The Invincible Reef lies on the western bank of Yandicoogina Creek, about a mile and a half south-west of the Uncle Tom line. The reef has been worked in two adjoining properties of six acres each, viz., the Invincible, G.M.L. 557, and G.M.L. 561. The main reef has an average strike of 281 degrees, and underlies to the south at angles varying from 25 to 30 degrees, and is enclosed in schist of the usual type. About 20 feet to the south is a parallel, though very thin, vein of laminated jasper (chert?) of the type which forms such a conspicuous feature in many of the other goldfields of the State. The quartz [5414] of the main Invincible Reef is a grey glassy variety, apparently entirely devoid of any accessory minerals other than gold. So far as may be seen, the reef is about 1 foot in thickness.

There are three shafts on G.M.L. 557, but, beyond two men engaged in dry-blowing, no work of any description was being carried out. The main shaft is said to have been carried down 39 feet vertically (at which depth the reef was met with), and continued some distance farther on the underlie of the reef. Water is standing in the underlie, which prevents anything being seen.

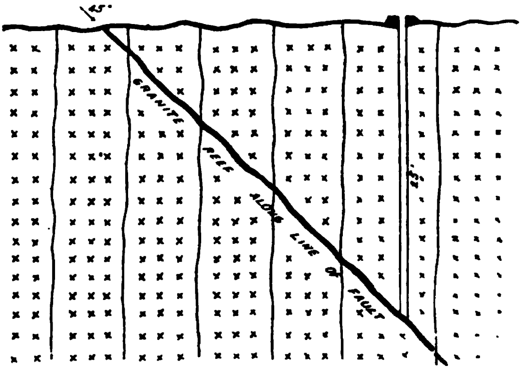
The Invincible Reef has a record of 52·31 ozs. to the ton, obtained from a crushing of 13·40 tons of quartz, which yielded

701 ozs. of gold. This crushing, which took place in 1899, is the only one recorded from the property.

GRANITE REEF.

What is known as the Granite Reef is situated some miles due north of the Black Shepherd, and, as may be inferred from its name, occurs in the granite area, which occupies such an extensive tract of country to the north of Yandicoogina. The reef, which, so far as can at present be seen, is only from 6 to 8 inches in thickness, has an average strike of 100 degrees, and an underlie of from 40 to 45 degrees to the north. Operations have been confined to sinking a vertical shaft, through granite, to the depth of 25 feet, and taking out the whole of the stone from this level to the surface.

FIG. 18.



SECTION ACROSS THE GRANITE REEF G.M L 586 YANDICOOCINA

The country rock, as is shown (Fig. 18), is traversed by vertical joints.

Some little distance to the west of this is another quartz reef, 1 foot 3 inches in thickness, underlying to the south at an angle of 31 degrees. Very little work has been done upon this reef. The quartz [5412] contains galena arranged in bands through the stone, and a little zinc blende in addition to free gold.

Table showing the Yield of the Granite Reef.

Year.	Name of Lease.	Ore Crushed.	Gold therefrom.	Rate per Ton.
		Tons.	Ozs.	Ozs.
1900	Granite, G.M.L. 586 . .	9·00	40·50	4·50
1901	,, ,, . .	26·00	52·00	2·00
	Total . .	35·00	92·50	2·64

In addition to the above-mentioned reefs, there are one or two others which are at present abandoned and to which access is not obtainable, hence any description thereof is impossible.

The following synoptical table gives the total gold yield of Yandicoogina obtained from official statistics up to the end of 1903:—

Synoptical Table showing the Yield of the Yandicoogina Reefs.

Name of Lease.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
Aunt Sally	27·00	21·00	·78
Black Shepherd	633·05	2,016·29	3·18
Eastern	665·85	777·55	1·17
Granite	35·00	92·50	2·64
Harp of Erin	22·50	11·55	·51
Invincible	13·40	701·00	52·31
Jupiter	113·50	586·70	5·17
Lady Adelaide	61·25	88·30	1·44
Lone Hand	16·00	23·30	1·45
Trilby	66·00	207·50	3·14
Uncle Tom	528·05[1]	1,553·21	2 94
Zingari	8·40	6·80	·80
Sundry Claims	84·75	385·00[1]	4·54
Total . .	2,274·75	6,470·70	2·62

Adding to this the 325 ozs. obtained by cyaniding 700 tons of tailings accumulated at the Lady Adelaide Battery and from the reefs it is impossible to specify, it appears that 6795·70 ozs. of gold from 2274·75 tons of ore has been obtained from the mining centre of Yadicoogina; and, so far as operations have at present gone, the average yield per ton of ore has been 2·98 ozs.

F.—Mount Elsie

The Mount Elsie Diggings are situated about 30 miles to the east of Yandicoogina, on the head-waters of Elsie Creek, one of the tributaries of the De Grey (Nullagine) River. The mountain from which the district takes its name rises to a considerable altitude above the general level of the surrounding country, and forms a very conspicuous feature in the landscape, visible for many miles in all directions. Mount Elsie itself is formed of schistose rocks, intersected by numerous laminated, iron-stained quartz reefs, with thin quartz leaders ramifying in all directions. These schists are sandwiched, as it were, between two belts of limestone-like weathering schist of the type common to those portions of the Pilbara Goldfield so far examined, as is seen in the geological section,

[1] Includes 284·50 ozs. dollied.

Fig. 7. The southern slopes of the hill are drained by a deep gully and its tributaries, and at the date of my visit two men were engaged in dry-blowing, with fairly successful results. The detrital gold in the creek is evidently of distinctly local origin, and owes its presence to the disintegration of the numerous quartz leaders by which the hill is traversed. What may be called the Mount Elsie belt is continuous for some miles to the south-east, and several well marked summits rise from different portions of the belt. One of the most prominent of these rises to a height of about 380 feet by aneroid above the camp at the base of Mount Elsie. This hill forms the continuation of what may be called the Mount Elsie Group of Reefs, which outcrop with more or less interruption along the summit and the flanks of the tortuous ridge, of which the hill forms a part. The hill itself is formed of decomposing greenstone, traversed by a network of somewhat quartzose ironstone veins. Several old workings and dry-blown patches attest the fact that the district must have been the scene of more or less desultory prospecting at one period of its history.

Another summit, about a mile to the north-east, is formed of what appears to be decomposed massive greenstone, intersected by veins of quartz and ironstone.

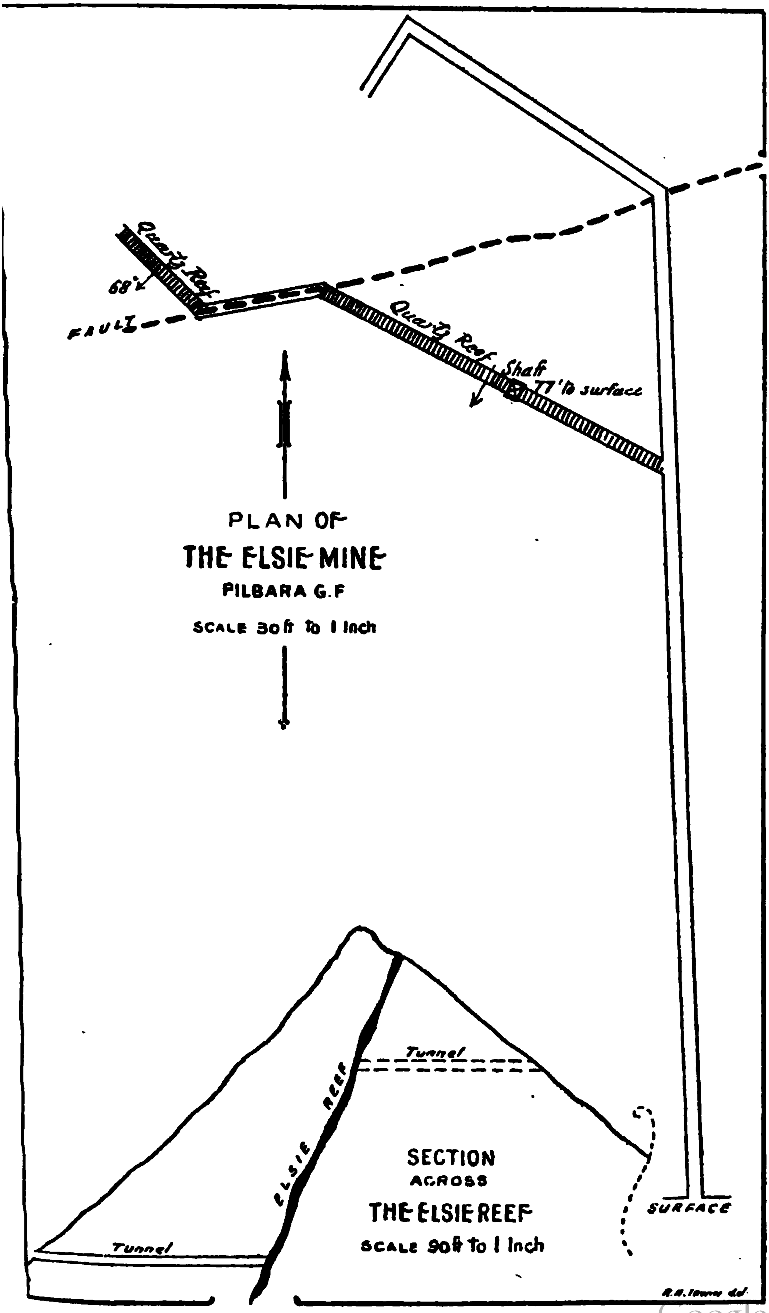
No mining operations of any kind were going on at the date of my visit to Mount Elsie, and, judging by the condition of affairs, very little had gone on for some considerable time.

Elsie, G.M.L. 86.—The only place at which any serious attempt at mining had been carried out was at the Elsie mine, which is situated at the foot of the hill from which the locality derives its name. A plan and section of the workings of this mine is shown in Fig. 19.

The Mount Elsie Mine is the same as that shown on the maps of the district as Duncan and Sullivan's Gold Mine.

The outcrop of the Elsie Reef forms the summit of a high ridge, which extends for a considerable distance to the west. The reef has been worked from the outcrop down to a point some 76 to 80 feet vertically below it, on an underlay of about 68 to 70 degrees. The reef has been worked along the outcrop for 104 feet from the mouth of the shaft. A crosscut has been put in northwards from the base of the hill at a few feet above the level of the creek. This crosscut, which had been carried through greenstone, intersected the Elsie Reef at a point 150 feet from the mouth; here, however, it is only an inch or two in thickness. As measured in the drive along the reef, the strike is 298 degrees. Twenty-six feet from the crosscut is the underlie shaft connected with the surface. At the foot of the underlie shaft the "reef" is made up as follows: Quartz, 1 foot on the footwall, and quartz 4 inches on the hanging wall, separated by about 12 inches of formation. A good deal of work had evidently been done below the level of the drive at the shaft, but very little could be seen owing to its inaccessibility. Thirty-four feet north-west from the shaft a cross-

FIG. 19.


Quartz Reef
68°
FAULT
Quartz Reef
Shaft
77' to surface
PLAN OF
THE ELSIE MINE
PILBARA G.F
SCALE 30 ft to 1 Inch
Tunnel
ELSIE REEF
SECTION
ACROSS
THE ELSIE REEF
SCALE 90 ft to 1 Inch
SURFACE
Tunnel

course (? fault) crosses the reef on a bearing of 260 degrees, and shifts the main reef westward about 20 feet; at this point it resumes its normal course (315), and has been opened out for a distance of 18 feet. The face of the drive, however, shows but 2 inches of quartz, underlying to the south-west at an angle of 68 degrees. The crosscourse (? fault) carries a little quartz; the crosscut has been carried about 40 feet north from the point at which it is crossed by the main reef, to what in all probability marks the extension of the crosscourse (? fault). Owing, however, to the similar nature of the rock throughout the whole length of the tunnel, rendering a fault, unless marked by a quartz reef, very difficult of detection, this cannot be definitely proved. The crosscut (?) has been continued for a farther distance of 49 feet along a bearing of 302 degrees, or roughly parallel to the main quartz reef, but, so far as may be seen, without opening up any fresh ore body. From the face of the tunnel the country to the south has been explored for a distance of 16 or 17 feet, but without any success.

Some distance farther west and at a very much higher level on the northern flank of the ridge, a tunnel, as shown in the section, Fig. 19, has been put in on a bearing of 221 degrees through greenstone for a distance of 94 feet to the reef, which proved to be 12 inches thick. Free gold was showing in the stone lying at the mouth of the tunnel, and which had obviously been obtained from the reef itself.

When the Elsie mine was at work the ore was crushed at a Tremaine Mill erected at the base of the hill; water for crushing purposes was obtained from a well put down in greenstone country in close proximity.

The yield of the Elsie Reef may be seen by an inspection of the figures in the table, which have been taken from official sources:—

Table showing the Yield of the Elsie Reef.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
1899	14·25	268·45	18·83
1900	28·00	204·00	7·28
1901	230·00	519·77	2·26
1902	136·00	421·60	3·10
Total . .	408·25	1,413·82	3·46

In addition to this, the official figures disclose that in 1901 20 tons of ore from sundry claims yielded 17·90 ozs. of gold, or at the rate of ·89 ozs. to the ton.

G.—Boodalyerri

The almost abandoned workings at Boodalyerri lie about six miles to the east of Mount Elsie, and occur in granite country, which occupies an extensive area in the vicinity. The workings, though in granite country, are situated not far from the boundary of the basic schists into which the granite is clearly seen to be intrusive. In the vicinity of the schists, the granite has a rude foliation, but whether this is of the same age as that which affects the schists cannot be satisfactorily made out. The greenstone schists are associated with beds of micaceous schists.

A series of photographs, showing the intrusive nature of the granite, were taken, as well as the workings at Martin's Mine; but, owing to difficulties of temperature, transport, &c., none of the negatives, on being developed, proved fit for reproduction.

GOLDEN GRANITE G.M.L. 601.

The Golden Granite Mine at Boodalyerri, worked by Mr. Martin, lies about 6 miles to the east of Mount Elsie, and is situated in the granite area which occupies such an extensive tract of country in this portion of the district. The deposit, so far as could be seen at the date the district was visited, consists, as shown in the generalised section, Fig. 20, of an irregular network of small quartz leaders (many of them less than a quarter of an inch in thickness), occurring in close proximity to a greenstone dyke. Mining operations have been carried out along a joint striking N. 40 W., and underlying at 65 degrees to the west. For some distance from either wall of the joint, which carries a thin vein of quartz, the granite has been altered into a greenish yellow rock [5395], the composition of which, as determined by Mr. E. S. Simpson, is shown by the figures in the table on page 7. The zone of decomposition has no defined boundaries, but passes almost insensibly into the normal granite of the neighbourhood. The decomposed rock contains small quantities of iron pyrites.

A vertical shaft, 32 feet distant from the outcrop, intersects the greenstone dyke at 20 feet from the ground level, at which point it is 4 feet in thickness.

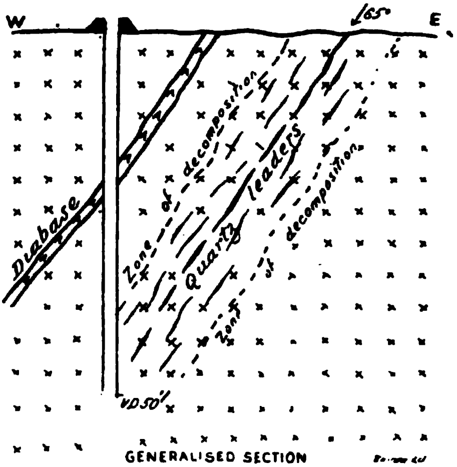
About 500 ozs. of alluvial gold are stated to have been obtained from the gully adjoining the reef, to the disintegration of which, the origin of the detrital gold may be ascribed. The official returns, however, show only 160 ozs. of alluvial gold from this centre; it is, however, probable that a good deal of the gold won has not been officially reported, or else it has been included in the returns from the "district generally."

Another rich leader about 197 feet north and 30 feet west from the main shaft has been worked, and about 16 tons of stone raised, which are said to have yielded 100 ozs. of gold. This leader, which occurs in a similar decomposed granite country, has been followed to a depth of 50 feet below the surface, at which point it cut out. The general strike of the leader practically coincides with that previously described.

The stone at the Golden Granite was crushed on the spot by a small 3-head mill driven by a windmill; and another smaller one was utilised for raising water from the dam to the battery tanks.

G.M.L. 617.—Some distance to the north-east of the Golden Granite Reef lies what was known as Bateman and White's Reward, at one time held as G.M.L. 617. The property, however, has been abandoned. So far as could be seen, the reef bears north 72 degrees west, and underlies to the south at a very high angle. About 6 tons of quartz from this vein are said to have yielded 93·50 ozs. of gold. The vein upon which operations have been carried out lies 150 feet distant from a very large quartz reef, which has an average strike of 162 degrees. The reward lease lies amid a network of reef and leaders, lying roughly parallel to one another.

FIG. 20.



GENERALISED SECTION
ACROSS THE GOLDEN GRANITE REEF BOOODALYERRIE

From what is known as the Granite Proprietary G.M.L. 598, there have been obtained 50 ozs. of dollied and specimen gold, whilst from sundry claims in the vicinity there have been officially reported in 1900 160 ozs. of gold, thus bringing the total yield of this small mining centre up to 1130·55 ozs.

The records show that the Golden Granite lease has produced the gold showing in the following table:—

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PLATE 6

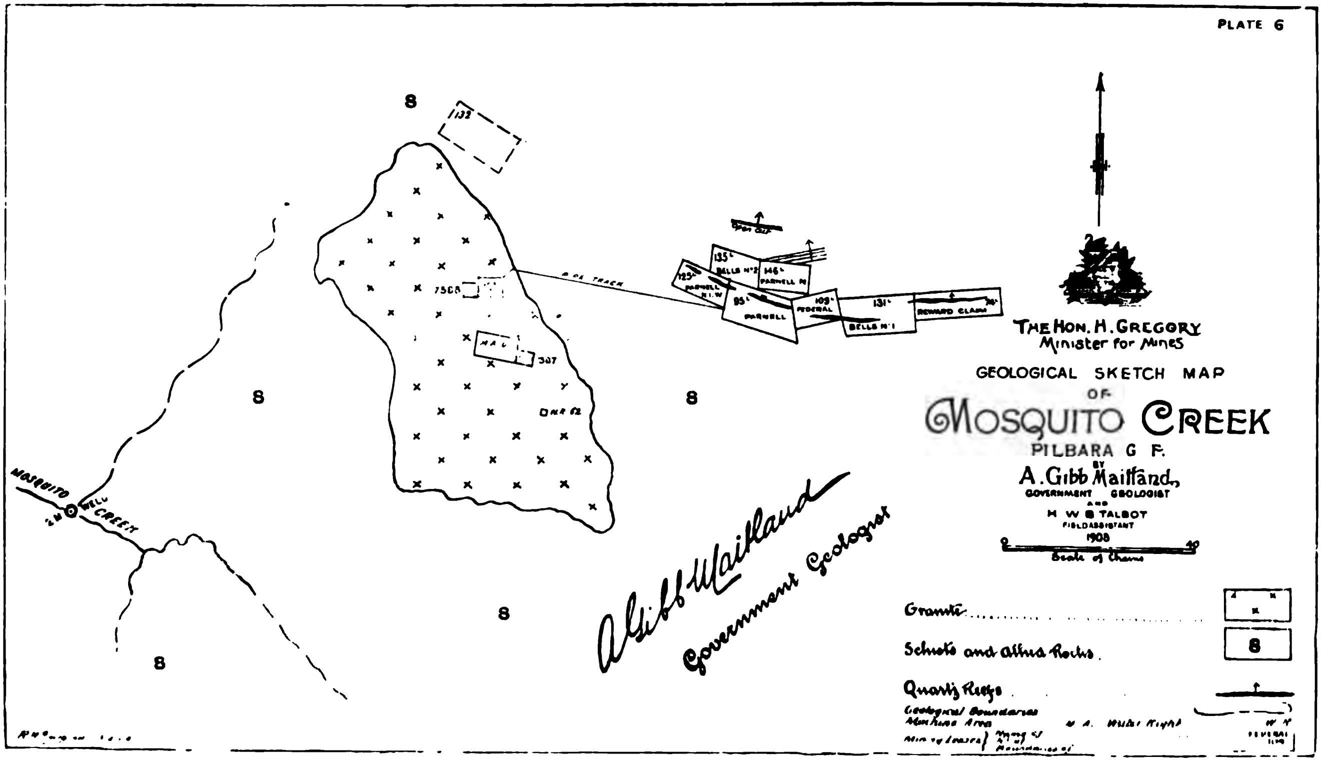

Table showing the Yield of the Golden Granite Reef.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
1901	14·25	[1] 250·00	17·54
1902	18·00	[2] 159·05	8·83
1903	74·00	418·00	5·65
Total . .	106·25	827·05	7·78

H.—Mosquito, Sandy, and Middle Creek Districts

(*With a Geological Sketch Map, Plate VI.*)

Mosquito Creek.—The reefing centre of Mosquito Creek lies about 24 miles due east of Nullagine, upon the head waters of the Nullagine River, and, according to the official statistics, has been responsible for 4715·58 ozs. of the gold from the Pilbara Field, as reported at the close of 1903.

The staple formation in the district consists of schistose rocks, which are either vertical, or, at any rate, inclined at high angles. These schists are associated with sedimentary rocks (grits, shales, and fine conglomerates), from which, however, they could not be satisfactorily separated. These sedimentary beds appear, *primâ facie*, to belong to an older series than those shown by the symbol **M** on the geological maps attached to the report, and inferentially assumed to be Cambrian (?). These beds of doubtful geological age which form the matrices of the auriferous reefs, have been invaded by granite rocks, a conspicuous boss of which [5425] forms an important feature at the township of Mosquito. The position of this is shown on the geological sketch map. This granite boss has a length of about 90, and a maximum width of about 40 chains, and rises to a considerable height above the level of the surrounding country, and makes a prominent feature in the landscape, and is visible from a distance of several miles.

The time at my disposal in the district was such as permitted questions of economic geology only being dealt with, hence there was little opportunity of investigating purely stratigraphical details, to the solution of which this district would afford ample important evidence.

THE REEFS

The following is such a description of the various mining properties as were open to inspection at the date of my visit; the location of many of the properties will be found on the geological sketch map of Mosquito Creek, and others on the 40 chain Lithograph, L 77, issued by the Department of Mines; the individual claims, however, not being surveyed, do not appear on any map.

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[1] Includes 74·00 ozs. of dollied and specimens.
[2] Includes 25·00 ozs. of dollied and specimens.

For convenience of description the properties are described in geographical order, commencing at the easternmost end of the field.

NICHOL'S REWARD, R.C. 74 L.—A small property comprising a little over 11 acres. Three shafts have been put down near the north-east angle of the lease. The northernmost shaft had been put down to a vertical depth of 100 feet, but at the date of my visit was inaccessible below a depth of 40 feet. The reef is very bunchy and irregular, but attains a thickness of from 6 to 8 feet in places. So far as may be seen in the workings, the reef occurs along a shear plane in the schists. A few feet to the south-west of this, two shafts have been sunk upon a quartz reef, which has an average strike of 89 degrees and a slight underlay to the north. The easternmost of the two shafts is stated to have been carried down to a vertical depth of 70 feet, but was inaccessible below 50 feet. A good strong reef, 10 feet in thickness, has been worked, but it appears to have gradually petered out, and at the foot of the shaft, it is said to be only an inch or two in thickness. The workings have been connected with another vertical shaft a few feet to the west. The reef is of the same nature and character as that in the northern shaft. So far as may be judged by the surface, there is every probability of the reef having a considerable horizontal extent, though everything points to the fact that it would be expected to be extremely irregular in its thickness.

The following table shows the crushings from this property, so far as may be gathered from the official statistics:—

Table showing the Yield of Nicol's Reward Reef.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
1900	125·15	232·05	1·85
1901	127·00	167·12	1·31
1902	162·00	190·60	1·17
1903	36·00	59·75	1·66
Total . . .	**450·15**	**649·52**	**1·44**

The fairly consistent returns from this property would seem to me to warrant rather more vigorous and systematic prospecting than has hitherto taken place.

G.M.L. 131 L.—A 12-acre lease adjoining the Reward Claim on the west. Very little work of any kind had been done on the lease. A ferruginous vertical quartz reef of about 2 feet in thickness enters the lease on its western boundary close to the south-west corner of the Federal, G.M.L. 97. This reef trends generally east and west, and appears to be of some horizontal extent. No work appears to have been done upon it.

Federal, G.M.L. 97 L. (109 L.).—A 6-acre lease between the Parnell and that previously described. A good deal of more or less desultory work has been carried out upon the lease.

Near the centre of the property, a water-shaft is being sunk under an agreement with the Government.[1] Near the north-west angle of the lease is another shaft 44 feet in depth, on a reef striking generally east and west, but not much work has been done upon it. Farther to the north on the lease some desultory work has been done upon a parallel reef.

According to the official returns, the two crushings recorded from this reef have averaged about an ounce and a quarter to the ton.

The following table gives the crushings from this lease :—

Table showing the Yield of the Federal Reef.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
1901	7·00	12·75	1·82
1902	41·00	46·45	1·13
Total . . .	48·00	59·20	1·23

Parnell, G.M.L. 95.—A 12-acre lease, owned by the Bell Exploration Company, upon which three shafts have been sunk, and a 10-head battery, to which it is proposed to add a cyanide plant, erected.

The most easterly shaft has been carried down to a depth of 87 feet upon a quartz reef underlying to the north. At the foot of the shaft the reef is about 3 feet thick, and at one place higher up it reaches as much as 5 feet. The hanging wall of the reef is a kaolinic decomposed rock, which has every appearance of being one of the sandy beds forming the sedimentary series. No driving has been done on the reef. Some distance to the south-west of this is another shaft, said to have been carried down to a depth of 80 feet, but at the date of my visit was inaccessible below about 30 feet from the surface. The reef is continuous with that occurring in the shaft previously mentioned. The reef is about 3 or 4 feet in thickness. Not much work, however, appears to have been done upon it. The main or water shaft has been sunk to a depth of about 160 feet, and two crosscuts put in to the southward at 100 and 160 feet respectively. The uppermost crosscut has been carried 40 feet, and the lower one about 20 feet, through a decomposed sandy rock, which has every appearance of being a sandstone or grit. The reef, which, so far as has been opened up, is small and irregular, occurs at the junction of the sandstone (?) and a very much harder and fine-grained rock, the nature of which cannot be satisfactorily determined, as the bed has only just been pierced.

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[1] On the 7th of March, the District Engineer in charge of the Mines' Water Supply, reports that the shaft was down 110 feet, without any sign of water being obtained.—A.G.M.

A supply of water, said to be sufficient to keep the 10-head mill running eight hours, is drawn from this shaft, but after a long period of dry weather a material difference in the yield is said to be noticeable.

According to the official figures, it appears that the yield of the stone crushed from this lease has been just over an ounce, and, as seen by the following table, only 357 tons of ore has been raised and crushed in three years:—

Table showing the Yield of the Parnell Reef.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
1900	59·00	79·30	1·34
1901	143·35	184·60	1·28
1903	155·00	120·50	·77
Total	357·35	384·40	1·07

Parnell No. 1 West, G.M.L. 96 L.—This is a 6-acre lease adjoining the one previously described. The easternmost shaft has been sunk to a vertical depth of 56 feet upon a reef which there is every reason to believe is the continuation of the one met with in the 87-feet shaft on the Parnell. As seen on the surface near the shaft the reef varies from 3 to 4 feet in thickness, whilst at the foot of the shaft it has dwindled to 12 inches. The hanging wall side of the reef is a squeezed or sheared slate. Another shaft, on what may be a parallel reef, has been put down near the northwestern corner of the lease. There was little to be seen of it. The only crushing from the Parnell West took place in 1901, when 36·75 tons of stone yielded 24·50 ozs. of gold, or at the rate of 0·66 ozs. to the ton.

Parnell North, G.M.L. 146 (formerly G.M.L. 102).—A 6-acre lease adjoining the Parnell on the north. A main shaft, 90 feet in vertical depth, has been sunk on a north-west and south-east reef said to be continuous with one occurring in the Federal lease, referred to above. The maximum thickness of the reef exposed is 5 feet, although the average varies between 18 inches and 2 feet. There is, however, very little to be seen of the reef owing to the condition of the workings. The stone [5427] shows free gold in places. A little work has been done on an east and west reef, which varies from 6 to 18 inches in thickness, but it is said to have been poor.

Four crushings have been recorded from this lease, as may be seen by the table of statistics, having an average yield of over an ounce and a half to the ton:—

Table showing the Yield of the Parnell North Reef.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
1900	46·50	162·00	3·48
1901	48·35	52·45	1·08
1902	60·00	54·90	·91
1903	41·50	41·00	·98
Total . .	196·35	310·35	1·52

At a point some distance to the north-west of the northern angle of G.M.L. 102 (146) an open-cut 187 feet in length has been put in on an east and west reef, occurring along the planes of bedding or foliation (?) of the schists, which at this point are vertical. There is, however, nothing to be seen, for all the workings have been filled in or are otherwise inaccessible.

Belle Vue, G.M.L. 129.—This lease has been abandoned, and four men's quartz claim has been taken up upon it. The ground embraced by the claim includes the old workings. A shaft 53 feet deep has been sunk upon a quartz reef underlying at 15 degrees from the vertical and to the north. The present holders of the claim, Messrs. Underwood & Co., commenced operations when the present shaft had been carried down 25 feet from the surface. On the western face, at the foot of the shaft, which is about 10 feet distant, the reef is only about 4 inches thick, while at the eastern face the reef measures as much as 2 feet 3 inches. Under foot, at the bottom of the shaft, the average thickness is about 1 foot. A little water was oozing out from the walls at the foot of the shaft. The reef occurs along a line of fault, the country rock is slate, and the fault is parallel to the planes of bedding, which show numerous slickensided faces parallel to the underlie of the reef. The reef is extremely irregular in its thickness. Free gold is showing in the stone and the casing; a little iron pyrites is also present. The only crushing recorded from this lease was during the year 1902, when 34·40 tons of quartz yielded 116·50 ozs. of gold, or at the rate of 3·38 ozs. to the ton, showing conclusively that a very rich chute had been struck.

A short distance to the east of the Belle Vue is a reef about 3 feet in thickness, worked by Messrs. Ross and Wetherall. Although the stone is 3 feet thick, it is only the 4 inches along the hanging wall of the reef which carries any gold. The reef occurs along the planes of foliation of the schists; no work, however, has been done upon it. A parcel of several tons is said to have yielded about 3 ozs. of gold to the ton; as the returns from this property do not appear in the official statistics under the name of Messrs. Ross and Wetherall, they are probably included under the heading of the yield from Sundry Claims.

The SUDDEN JERK is an unregistered claim, which has been taken up on an east and west reef occurring along the planes of foliation of the schists, which underlie at a high angle to the north.

A shaft was being sunk on the reef, which, at the date of my visit, had been carried down about 20 feet, and at the foot, on the western face, a "shear zone" of about 3 feet in thickness was exposed. This "zone" contained numerous quartz veins, mostly of small size; there, was, however, about a foot of quartz on the hanging wall. The reef on this property has been extensively worked along the outcrop for about 2 to 3 feet from the surface, but nothing very definite appears to be known as to its yield, which in all probability is included under the heading of Sundry Claims.

RATTLER, G.M.L. 130 (formerly G.M.L. 93).—This is a 12-acre lease, situated about 160 chains to the south of the Two-Mile Well at Mosquito, but has long since been abandoned. So far as may be seen there are two parallel reefs upon the lease, which outcrop on the summit and flanks of the hill, upon which the old workings are situated. Near the base of the hill a tunnel has been put in 75 feet due north until it reached an east and west reef, from which about 66 tons of ore had been obtained. The country rock is plicated schist of the usual type, and the reef appears to occur along the planes of foliation. Nothing, however, can be seen of it at the present time. Little or nothing has been done upon the uppermost vein. The official statistics given below show, however, that the average return has been over 2 ozs. to the ton, from which it would appear that a rich chute had been met with:—

Table showing the Yield of the Rattler Reef.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
1899	17·00	59·50	3·50
1901	22·00	29·00	1·32
1902	27·00	48·60	1·80
Total . .	66 00	137·10	2·07

HUGH WILKIE'S CLAIM.—A prospecting shaft had been sunk to a depth of 10 feet upon a vein of quartz 12 inches in thickness, underlying to the north. The reef is encased in schist country of the type prevailing in the district. There were about 5 tons of quartz at grass.

Galtee More, G.M.L. 79.—The Galtee More Reef traverses the whole length of the 6-acre lease near the northern boundary, and has been opened up in several places, but most of the workings are inaccessible at the present time. The average crushings since the year 1898 have been over 2½ ozs. to the ton, and over £900 is reported to have been spent on carting the stone to the battery, the charges being about £2, 10s. per ton.

There are two main shafts on the property; the easternmost shaft is 80 feet vertical, and is connected underground with the western shaft, 110 feet distant and 100 feet in depth. The 80-feet shaft has been carried down on the reef, from a point about 30 feet below the level of the surface. At the foot of the shaft the quartz is about 2 feet thick, occurring on the hanging wall of a "formation" of 4 feet in width. The "formation" consists of fissile and plicated slates or schists carrying a little iron pyrites and numerous quartz veins. The drive connecting the two shafts was inaccessible, and I am credibly informed the thickness of the quartz exposed did not fall below 18 inches. The western or 100-feet shaft struck the reef at 80 feet from the surface, and had been followed down upon the underlie for some distance. The thickness of quartz exposed varies from 12 to 18 inches. The underlie of the reef is not nearly so steep as in the other portions of the workings, suggesting that the reef has either (*a*) been faulted or (*b*) folded. About 300 tons of stone were at grass at the mouth of the deep shaft awaiting crushing. Considering the facilities for exploitation which this mine appears to possess, and the consistent high yield of the reef, as shown by the official statistics below, it is much to be regretted that the mining operations had not been more systematically carried out.

Table showing the Yield of the Galtee More Reef.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
1898	16·00	69·00	4·31
1899	165·00	433·25	2·62
1901	199·00	401·95	2·02
1902	104·00	386·95	3·72
Total . .	484·00	1,291·15	2·66

Galtee More West, G.M.L. 128.—A 12-acre lease, adjoining the last. A shaft, 110 feet in vertical depth, had been put down with the object of exploring the extension of the Galtee More Reef.

The shaft, however, was inaccessible, except at some personal risk, and no information was available.

Galtee More North, G.M.L. 85.—The name of this abandoned 17-acre lease implies that it is situated on the northern extension of the Galtee More Reef. This lease, however, lies 30 chains to the north of the latter, and the reef upon it trends generally east and west. Work ceased some years ago, and little or nothing is now to be seen of the workings. A small crushing of 17·25 tons yielded, in 1899, 35·20 ozs. of gold, or at the rate of 2·04 ozs. per ton.

Latest Surprise, G.M.L. 127 (formerly G.M.L. 88, Latest Surprise, and G.M.L. 78, Surprise).—A lease about 25 chains due west of the Galtee More group, embracing an area of about 6 acres. A shaft has been put down to a depth of 94 feet on an east-and-west reef underlying to the north at a very high angle. At the foot of the shaft the thickness of the reef is 15 inches. A drive 77 feet in length has been put into the west. At a point in the drive, 30 feet from the shaft, a second has been sunk to a depth of 50 feet from the floor of the level. A drive 10 feet in length has been opened out on the western side of the shaft, and a solid quartz reef of 24 inches in thickness exposed. The quartz contains a little carbonate of iron. The reef occurs in sheared slate, and apparently occurs along a line of fault. The sheared country rock contains small quantities of iron pyrites disseminated through it. In the eastern face, at the foot of the shaft, there is a thickness of about 3 feet of quartz. The ribboned zone contains lenticules of quartz. The reef has been worked to the surface from about 100 feet. The workings, which, however, are not extensive, are the deepest in this portion of the district.

Considering the high returns from this reef, as shown in the official statistics in the table below, and the facilities for exploitation which it presents, somewhat more systematic work would appear to be warranted.

Table showing the Yield of the Latest Surprise Reef.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
1898	16·00	108·10	6·75
1899	44·25	84·00	1·89
1902	80·00	197·00	2·46
1903	108·00	179·00	1·66
Total . .	248·25	568·20	2·28

Ard Patrick, G.M.L. 143.—A shaft has been sunk to a depth of 80 feet, and at 60 feet a quartz reef of 6 inches was struck. A drive has been put in 20 feet to the east, and the reef increased to nearly 3 feet in thickness. The lower level at 80 feet was inaccessible, but it is said to have been driven 30 feet eastward and half that distance to the west. There were about 60 tons of quartz at grass, in which free gold was showing both in the stone and on the faces. The stone prospected well. There were about 60 tons of quartz at grass awaiting crushing.

King Billy.—An abandoned quartz claim. A quartz reef of no great thickness occurs on the north side of a vertical dyke of greenstone, striking north 75 degrees west. Not much work appears to have been done. The returns from this property are probably included in the yield of Sundry Claims, as shown in the official statistics. I have been credibly informed, however, that there have been two crushings—one of 8 tons, which yielded 15 dwts., and another of 20 tons, yielding 10 dwts. to the ton.

Last Resource, Q.C. 223.—A quartz claim held by Maurice Chaivi, W. Britten, and J. Corrin. A quartz reef, striking generally east and west, and underlying at a high angle to the south, has been opened up for about 100 feet along the outcrop by the previous holders of the ground.

A shaft about 80 feet in depth has been sunk on the reef, and drives put in to the east and west from the bottom. The western level has been driven 27 feet; at the foot of the shaft on the west the quartz is only 6 inches thick The reef is continuous to the face of the drive, where there is about 12 inches of quartz showing underfoot. The eastern drive, which was inaccessible, is stated to have been carried 30 feet. The country rock is schist of the type prevailing in the district, and the reef occurs along a shear zone.

About 50 feet east is another reef, which has been opened up, but it is said to have been too poor to be worth working.

In 1903, a crushing of 9 tons is recorded as having yielded 13·50 ozs. of gold, or at the rate of 1·50 ozs. per ton; previous to this the yield has been shown under the heading of Sundry Claims. The total tonnage is said to have been about 50 tons, with an average yield of about 2 ozs. to the ton.

Monte Carlo West, Q.C. 235.—A quartz claim held by Messrs. Connolly, Clemmenson, and Leonard. Nothing was to be seen underground at the date of my visit; the quartz reef occurred along the planes of foliation of the schists, which trend generally east and west, and dip to the north at a high angle. In 1903, about 20 tons of ore crushed yielded 52·80 ozs. of gold, or at the rate of 2·57 ozs. to the ton.

Messrs. **Park and Ross's Ground**, which would appear to have been abandoned, lies some miles to the north of Mosquito. The strike of the outcrop of the reef is 83 degrees, and occurs along the planes of foliation, which dip at a high angle to the south. The reef has been worked for some distance along the outcrop, and a considerable body of stone taken out. The reef has been followed down in one place to a depth of 33 feet. At the foot the width between the walls of the "formation" is about 2 feet, and the total thickness of stone about 14 inches. The bulk of the quartz is on the hanging wall of the formation. A short distance lower down the eastern slope of the hill upon which the above reef outcrops, a drive has been commenced upon the outcrop of the reef (a line of fault), but only about an inch of quartz obtained. This drive is about 20 feet from the surface, and 20 feet above the level of the creek. Free gold is showing in the stone at grass.

The following is a synoptical table showing the yield of the reefs at Mosquito, in so far as may be gathered from the official statistics up to the close of 1903:—

Synoptical Table showing the Yield of the Mosquito Creek Reefs.

Name of Lease.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
Bannockburn, G.M.L. 118	17·00	11·25	·66
Belle Vue, G.M.L. 129	34·40	116·50	3·38
Federal, G.M.L. 97 (109)	48·00	59·20	1·23
Galtee More, G.M.L. 79	484·00	1,291·15	2·66
Galtee More North, G.M.L. 85	17·25	35·20	2·04
Last Chance, Q.C. 208	24·75	46·90	1·89
Last Resource, Q.C. 223	9·00	13·50	1·50
Latest Surprise, G.M.L. 127	248·25	568·20	2·28
Monte Carlo, Q.C. 219	15·80	48·95	3·09
Monte Carlo West, Q.C. 235	20·50	52·80	2·57
Nichol's Reward, R.C. 74	450·15	649·52	1·44
Parnell, G.M.L. 95	357·35	384·40	1·07
Parnell North, G.M.L. 146	196·35	310·35	1·52
Parnell No. 1 West, G.M.L. 96	36·75	24·50	·66
Rattler, G.M.L. 130	66·00	137·10	2·07
Sundry Claims	614·24	966·06	1·56
Total	2,639·79	4,715·58	1·71

SANDY AND MIDDLE CREEKS.—The Sandy and Middle Creek districts are embraced within a mineral zone which extends from Mosquito to Nullagine for a distance, as shown by the lithographs L 76, L 77, issued by the Department of Mines, of 24 miles. Geologically the districts are identical with that of Mosquito.

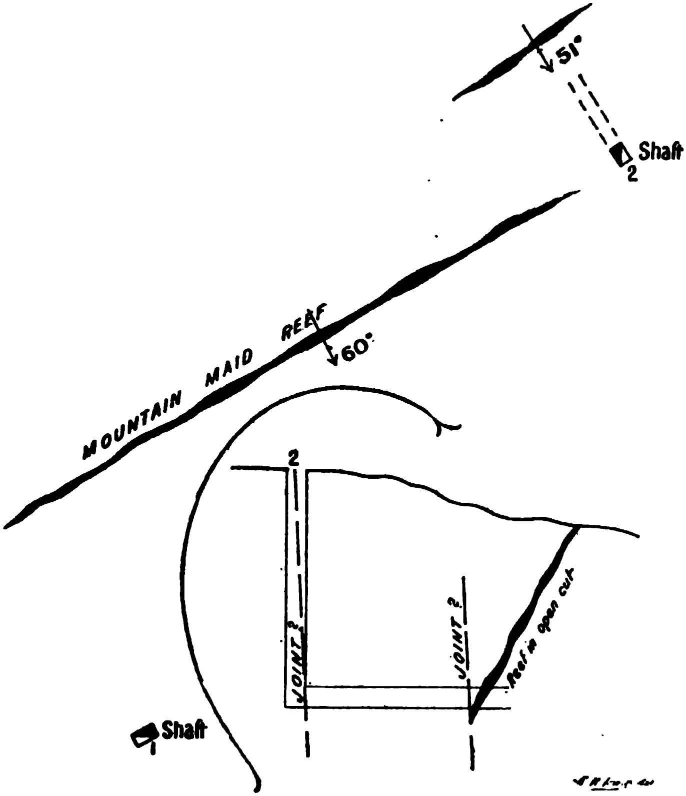
The following is a description of such of the mines as were open to inspection at the date the district was visited. The location of the most important will be found by reference to the lithographs enumerated above.

THE REEFS

To facilitate reference, the properties are described in geographical order, commencing at the easternmost end of the field

THE REWARD (The Mountain Maid).—The reef opened out on his property is situated on the summit of a high ridge, bearing rom the cairn west of M.A. 5, Sandy Creek, and east of the Galtee Moore Group, 104 degrees 30 seconds, and from the Battery Site, M.A. 5, 231 degrees. As measured along the outcrop the reef has an average strike of 58 degrees, with an underlie of 51 degrees to outh 34 degrees east, and is a good solid body of quartz, averagng about 3 feet in thickness. The quartz is pure white, contains a little green carbonate of copper, together with small quantities of iron pyrites. The country rock in the vicinity consists of shales and fine conglomerate, inclined at a high angle to the south. The reef has been prospected by means of two shafts 69 feet apart. The relative position of these is shown in the Fig. 21.

FIG. 21.



PLAN & SECTION OF THE MOUNTAIN MAID REEF SANDY Cᴷ PILBARA G. F

Shaft (1), 23 feet back from the outcrop, had been carried down through the country rock to its intersection with the reef, 40 feet below the level of the surface. No work was being carried out in the shaft.

Shaft (2), 20 feet in depth, through country rock; in the shaft there is a wall underlying to the north, which may be a line of fault. and possibly represents the continuation of the Mountain Maid Reef. From the foot of the shaft a crosscut has been put in to the north for a distance of 18 feet and cuts the reef at the bottom of the open cut on the brow of the hill to the north. In the crosscut it appears as though the reef is cut off by a fault parallel to the one showing in the shaft.

There are about 20 tons of quartz at grass. It is stated on reliable authority that one crushing of 6 ozs. and another of 26 dwts. to the ton have been obtained from this reef. The annual official statistics do not show any separate yield from this property, any returns being probably included under the heading of Sundry Claims.

Round Hill (Mr. McColl).—Two men were at work at the date the locality was visited. There are several workings on this claim.

An inclined tunnel 43 feet in length, driven on a bearing of 277 degrees, the section in the tunnel which has been carved out of almost vertical slates, shows from the slickensided faces that the reef is along a fault. At one spot in the tunnel there is about 3 feet of quartz, but at the face practically no stone is showing; the reef underlies to the south. Twenty-six feet from the mouth of the tunnel, and on a bearing of 136 degrees 30 minutes, a shaft was being sunk, with the object of intersecting the tunnel reef, and then driving westward underneath the workings. Free gold was showing in the loose rubble lying at the surface near the mouth of the tunnel, and the shaft.

There are several roughly parallel reefs on the ground, some of which have been merely opened up, but no other work done upon them. They all lie parallel to the planes of either bedding or foliation of the country rock. A shaft had been sunk to a depth of about 10 feet on a vertical reef 18 inches in its thickest part. At the bottom of the shaft, however, there is only 6 inches of quartz.

There was virtually no stone at grass except such as has been left by previous prospectors.

Bow Bells Claim.—There are two reefs on the property—an eastern reef striking 232 degrees and underlying west, and a western reef about 23 feet distant, which strikes 254 degrees and underlies to the east. The eastern reef has been opened up along the surface for a distance of about 40 feet, and at the southern end of the trench excavated to a depth of 10 feet. The reef outcrops for a considerable distance both north and south of the trench, but very little work would appear to have been done upon it. The thickness of the reef varies from 1 to 3 feet. Stone taken from the reef shows free coarse gold. Some crushings are said to have been obtained from this reef; the returns, however, are probably included under the heading of the yield from Sundry Claims. The western reef has been opened up for 120 feet along the outcrop. The greatest depth at which the reef has been followed is 10 feet. The quartz varies in thickness from 1 to 4 feet. About 5 tons of quartz had been raised, and were awaiting crushing at the date of my visit.

Central, G.M.L. 137 (formerly G.M.L. 126).—A 12-acre lease held by Mr. McGuire is situated in a locality to the west of Camel Creek, in which many reefs outcrop.

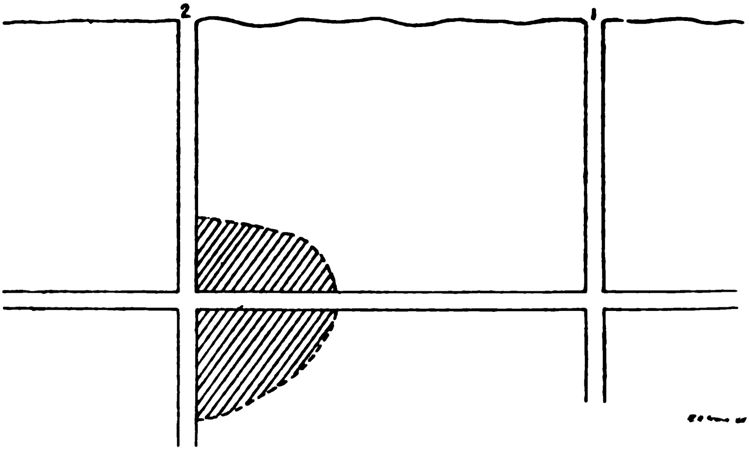
A vertical shaft 130 feet deep has been put down on a reef having an average strike of 78 degrees. The reef has been opened out on the surface 130 feet west of the shaft and 100 feet east of it. The average thickness of the reef is a little over 6 inches. From a point about 63 feet east of the vertical shaft the reef has been stoped to a depth of 30 feet, and to a similar depth on the west from about 30 feet west of the shaft. At a depth of 100 feet an eastern drive has been put in for a distance of 33 feet, and at the face there are from 6 to 8 inches of quartz showing; the face of the western drive is 21 feet from the shaft, but the reef is only represented by about 1 inch of quartz. About 80 to 90 tons of quartz had been raised, and were awaiting crushing.

In the year 1902, 35·75 tons of quartz were raised and crushed, and the yield, as shown by the official statistics, amounted to 125·85 ozs. of gold, or at the rate of 3·52 ozs. to the ton.

Little Wonder, G.M.L. 136.—There are two shafts upon this lease, 120 feet apart, and connected by a level at 76 feet from the surface, as shown in Fig. 22. The outcrop of the reef bears 130 degrees. At the 76-feet level in the southernmost shaft the reef has been worked out to about 20 feet above the drive to the north-west; here a very rich crushing of about 10 ozs. is said to have been obtained. A drive has been put into the north for a distance of 19 feet, and at the face is an inch of quartz; the drive is through country all the way.

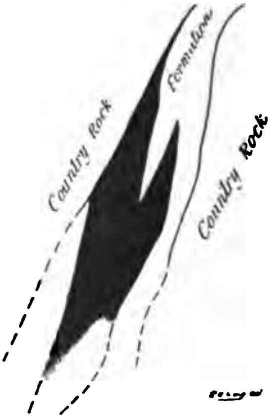
Along the drive connecting the two shafts the reef varies from 9 inches to 5 feet. No. 1 shaft has been put down on the reef all the way from the surface. About 9 inches of quartz is exposed at the foot of the shaft. At the face of the drive, about 15 feet west from the shaft, the reef is represented by only a few inches of quartz. From shaft No. 2 the drive has been continued to the east for a distance of 49 feet, on practically no quartz, but all formation. From the foot of shaft No. 2 a crosscut has been put in to the north for a distance of 16 feet to the reef, through formation. An easterly drive has been continued 30 feet along the reef. Eighteen feet up from the bottom of the shaft there is a thickness of 10 feet of quartz, carrying only 1 foot of formation. A 6-oz. crushing is said to have been obtained from this portion of the reef. From what can be seen in this portion of the workings it appears that the Little Wonder Reef is exceptionally irregular in its behaviour, and the rich patches hitherto opened up occur in the wider portions of the lenticular veins. The Fig. 23 gives an illustration of the occurrence of the reef in the shaft below the 76 feet level. From the slickensided faces, &c., it appears that the reef occurs along a line of fault. About 12 tons of what was believed to be rich stone was at grass at the date of my visit, together with 200 tons of seconds, a trial crushing of

FIG. 22.



LONGITUDINAL SECTION OF THE WORKINGS ON THE LITTLE WONDER REEF SANDY C^{K} PILBARA G F

FIG. 23.



SECTION OF THE LITTLE WONDER REEF SANDY C^{K} PILBARA G.F.

about 20 tons of which are said to have yielded 16 dwts. of gold per ton.

According to the official returns, the Little Wonder Reef has crushed 344 tons of ore for an average yield of over 7 ozs. of gold per ton; it certainly warrants a systematic scheme of development.

Table showing the Yield of the Little Wonder Reef.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
1902	63·00	624·90	9·92
1903	281·00	1,882·37	6·69
Total . .	344·00	2,507·27	7·05

Little Wonder West, G.M.L. 138L.—There are two shafts upon this reef, which is believed to be the extension of the Little Wonder. The westernmost shaft has been carried down 21 feet on a formation 3 feet wide, carrying quartz veins. One of these measured about 20 inches across, but at the foot of the shaft it proved to be much smaller. This reef is said to have prospected up to 4 ozs. per ton at the surface, but proved to be very poor at the bottom. There are about from 10 to 15 tons of stone at grass. The eastern shaft has been sunk to a total depth of 103 feet; the shaft being sunk 33 vertically to the reef and continued for a farther distance of about 70 feet on the underlie, which is at 45 degrees to the north. From the foot of the shaft drives have been put in to the east and west for distances of 60 and 40 feet respectively. The reef occurs along a line of fault, but there is very little stone showing. A small 4 oz. crushing is said to have been obtained from the outcrop of the reef.

Eureka, G.M.L. 139.—A vertical shaft sunk to a depth of 110 feet on a "formation" with a little rubbly quartz, in reality "fault rock." At 70 feet the width between the walls is 7 feet; the best gold is said to have been obtained from the stone on the hanging wall. From a depth of 110 feet, a portion of the shaft inaccessible at the date of my visit, a crushing of 20 tons is said to have yielded an average return of 4 dwts. to the ton. A shaft some distance to the north-west of this has been put down to a depth of 20 feet, on a small quartz leader, but no other work has been done.

During 1903, the official statistics demonstrate that 82·20 tons of ore from the Eureka property yielded 75·65 ozs. of gold, which works out at the average rate of ·92 ozs. to the ton.

Federation, Q.C. (originally G.M.L. 91).—Work was being carried on on a quartz reef 8 to 10 inches in thickness, having an average strike of 234 degrees, and an underlie to the north-west. The reef outcrops on the eastern face of a ridge, and forms the highest summit of it. The reef occurs along a line of fault, and was being worked by means of an open cut 10 feet in depth and 30 feet in length at its deepest point, and about 18 tons of ore have been raised. The prospectors informed me that there is about 10 feet of the country rock on either side of the reef, which carries gold up to about 10 dwts. A good deal of desultory work appears to have been done on the property by the previous holders of the ground, and the official returns show that the yield has been over 3 ozs. to the ton.

At the western end of the property a good deal of work has been done on a "formation reef" bearing 100 degrees. This deposit is a "shear zone," several feet in width, and intersected by irregular quartz veins. It is stated that 160 tons of this yielded 11 dwts. per ton. These figures, however, do not appear in the published annual returns, and may possibly be included under the heading of the yield from Sundry Claims.

Table showing the Yield of the Federation Reef.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
1899	49·50	152·15	3·07
1900	5·50	17·70	3·21
Total . .	55·00	169·85	3·08

Federation Extended, G.M.L. 92.—An adjoining lease of 5 acres, which, however, is now abandoned, and nothing is to be seen. In the year 1900, 6 tons of ore are reported officially to have yielded 31·10 ozs. of gold, or at the rate of 5·18 ozs. to the ton.

All Nations (formerly G.M.L. 82, 108).—Ten acres. The general strike of the reef is 4 degrees 30 seconds. A new main shaft has been put down at the northern end of the ground. Although a good deal of work must have been done in previous years, very little is to be seen at the present time.

The official returns from this lease are as follows:—

Table showing the Yield of the All Nations Reef.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
1899	136·00	432·40	3·18
1900	132·00	223·80	1·69
1901	61·00	148·50	2·43
1902	67·50	58·11	·86
1903	5·00	5·30	1·06
Total . .	401·50	868·11	2·11

All Nations South, Q.C.—A quartz reef from 1 to 3 feet in width, having an average strike of 20 degrees. The reef has been worked by an open cut for 95 feet along the outcrop; and at its southern end is a shaft 25 feet in depth. The deposit is a fault line along the foliation (? bedding) planes of the schists. There are about 22 tons of stone at grass awaiting crushing. It is not quite clear whether this ground is embraced within the limits of the old All Nations Lease.

Kingsmill, Q.C.—The Kingsmill Reef has an average strike of 344 degrees, with an underlie to the west. An underlie shaft has been sunk to a depth of 57 feet. At the bottom of the shaft the width between the walls of the formation carrying the reef is as much as 5 feet, although there is only 12 inches of quartz on the hanging wall. A drive has been put into the south for a distance of 20 feet, along the formation; at the face a few quartz stringers are showing. The stone has been stoped out to a point about 9 feet from the head of the drive. There are about 30 tons of quartz awaiting crushing. In 1903 the official returns show that 24 tons of ore crushed yielded 48 ozs. of gold, or at the rate of 2 ozs. to the ton.

Triple Alliance, Q.C.—The Triple Alliance has an average strike, as measured along the outcrop of N. 56 E., with an underlie to the south-east. A vertical shaft 24 feet in depth has been put down upon it. At 20 feet the reef is only from 6 to 8 inches thick, but its size has increased at the foot of the shaft to from 3 to 4 feet. The country rock is slate. The same reef has been opened up by an underlie shaft, a few feet farther to the north, but owing to the shaft being filled in nothing can be seen of its character. At the surface, however, its thickness is 12 inches. A crushing from this shaft is said to have yielded an average return of 26 dwts. to the ton; there were about 2 tons of stone awaiting crushing. This, what may be called the "main reef," is crossed by another underlying south and trending east and west. A second reef parallel to the main body lies 78 feet distant, on a bearing of 341 degrees, but no work has been done upon it.

Yes or No, Q.C. (formerly G.M.L. 90).—A quartz reef striking north-east and south-west has been opened up for some distance along the outcrop. A vertical shaft 80 feet in depth has been

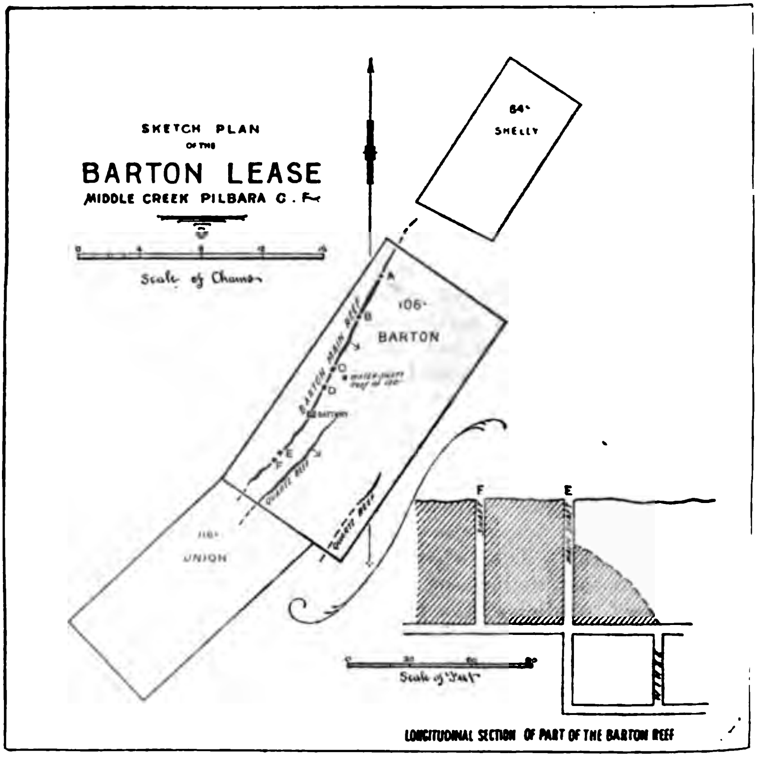
Table showing the Yield of the Yes or No Reef.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
1899	19·00	39·50	2·32
1903	15·00	60·00	4·00
Total . .	32·00	99·50	3·10

put down at a point 29 feet back from the outcrop, and met with the reef at the bottom. The reef was followed on the underlie for a distance of 30 feet farther. About 7 or 8 tons of stone had been raised, and awaited crushing.

Barton, G.M.L. 109.—The Barton Reef is one of the most continuous in the district yet examined. It traverses practically with little or no interruption G.M.Ls. 116, 106, 84, and possibly M.L. 11, and G.M.L. 113; the location may be seen by reference to the 40 chain lithograph issued by the Department of Mines. The Barton Reef is strong and well-defined; it enters G.M.L. 106, on the southern boundary of the lease, at about 100 feet from the south-west corner, and continues without interruption to the northern boundary of the lease, thus having a proved outcrop of at least 1250 feet.

Fig. 24.



As may be seen by the sketch plan forming Fig. 24, the deposit has been opened up by six shafts put down along the outcrop of the reef. In addition to this the reef is intersected in the water-shaft (distant 58 feet from C) at about 120 feet from the surface. Shaft A, which was inaccessible, has been carried down on the reef to a depth of 15 feet, at the foot of which it is stated that the reef attained a thickness of 6 feet. Shaft B was likewise inaccessible, and attained a depth of 30 feet. Shaft C had been carried down on the reef to a depth of 65 feet, but beyond sinking the shaft nothing appeared to have been done. At the foot of the shaft the reef measures about 4 feet from wall to wall, and from the information supplied to me by the Manager it would not appear to have proved payable at the bottom. Down to about 53 feet the stone is stated to have been payable. It is contemplated continuing this shaft by following the reef down to the depth at which it is met with in the water-shaft, viz., 120 feet. Shaft D had, at the date of my visit, been carried down to a depth of 40 feet. At the foot of the shaft a drive had been put in for a distance of 35 feet northwards, and the stone stoped out to about 10 feet from the surface. Southwards from the shaft the drive had been continued for a distance of 40 feet along the reef, which varied from 7 to 8 feet in thickness. The stone has been stoped out to within 10 feet of the outcrop from this level. Shaft E attains a depth of 110 feet, and has been carried down on the reef, the underlay of which is about 65 degrees to the south-east. At a depth of 60 feet levels have been opened up to the north and south for distances of 40 and 80 feet respectively. In the northern drive, 40 feet from the shaft, a winze has been carried down to the 110-feet level; the reef is represented by a schistose formation, intersected by several quartz veins. The reef has been stoped out for a distance of 40 feet along this drive to a point about 20 feet from the mouth of the shaft. The southern drive has been carried for a distance of 80 feet from the main shaft, and at 39 feet therefrom it intersects shaft F, which is 60 feet deep. The maximum thickness of stone in this drive is 8 feet 8 inches. The whole of the stone in this drive has been stoped out to within 3 feet of the outcrop. The main shaft has been continued from the 80-feet level down to 110 feet, from which point a level has been driven 95 feet to the north. The reef at the foot of the shaft, as showing on the south side, is 4 feet thick, and at the face of the drive it has dwindled down to 12 inches. No work has been done at this level.

As shown by the official figures, the average yield of the Barton Reef has been just over an ounce and a quarter to the ton.

There is a 10-head stamp battery, one berdan pan, two boilers and engines, and two steam pumps on the lease.

This battery is available for public crushing at the following rates:—For parcels up to 20 tons, 35s. per ton; and 30s. per ton for any quantity over that. During the year 1901, 1902, and up to the end of November 1903, the stone crushed for the public amounted to 1,693·71 tons, yielding 5,940·40 ozs. of gold, whilst the stone from the Company's own property is as set forth in the following table:—

Table showing the Yield of the Barton Reef.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
1898	56·00	88·50	1·58
1899	30·00	18·30	·61
1900	144·00	204·20	1·41
1901	356·65	373·10	1·04
1902	622·00	876·60	1·40
1903	802·00	1,046·20	1·31
Total . .	2,010·65	2,606·90	1·31

UNION, G.M.L. 116.—The Union Reef, which has an average strike of 196, has been opened up by means of a tunnel 64 feet in length, which has been driven on a bearing of 289 degrees. The reef is intersected at the face of the tunnel, and measures 4 feet in thickness. Any returns from this property are included under the heading of the yield of Sundry Claims, as shown in the official statistics.

MUNDALLA, Q.C. 215 (G.M.L. 103).—A 6-acre lease lying some distance to the north-east of Castle Rock. There are some old workings on the property which are hardly accessible; the reef opened up runs east and west. A main vertical shaft has been carried down to a depth of 130 feet. From the foot of the shaft a crosscut 28 feet in length has been put into the reef, which lies to the north. The reef is vertical. At the face of the crosscut is an old shaft, which had been put down on the reef. From the drive the reef has been stoped out up to the surface. A winze 34 feet deep has been sunk 19 feet west of the shaft. The quartz is showing in the western face of the winze only 4 inches in thickness. Slickensided faces occur on the quartz on the hanging wall of the reef. The ground is damp, indicating an approach to the water level. The quartz carries a little galena and iron pyrites.

According to the official returns as shown in the table below, the Mundalla reef has had an average yield of over 5 ounces to the ton.

Table showing the Yield of the Mundalla Reef.

Year.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
1900	91·30	334·95	3·66
1901	92·00	573·30	6·23
1902	30·00	266·80	8·89
Total . .	213·30	1,121·70	5·25

The following is a synoptical table showing the yield of the reefs of Sandy and Middle Creeks up to the close of 1903, so far as can be gathered from the official figures:—

Synoptical Table showing the Yield of the Sandy and Middle Creeks Reefs.

Name of Lease, &c.	Ore Crushed.	Gold therefrom.	Rate per Ton.
	Tons.	Ozs.	Ozs.
All Nations, Q.C. (G.M.L. 108) .	401·50	868·11	2·11
Barton, G.M.L. 106	2,010·65	2,606·90	1·31
Central, G.M.L. 137 (126) . .	35·75	125·85	3·52
Daisy, G.M.L. 89	21·00	64·20	3·05
Dominion, Q.C. 205	10·50	14·71	1·40
Eureka, G.M.L. 139	82·20	75·65	·92
Federation, Q.C. (G.M.L. 91) . .	55·00	169·85	3·08
Federation Extended, G.M.L. . .	6·00	31·10	5·18
Gem, Q.C. 214	20·50	32·80	1·60
Hidden Treasure, Q.C. 126 . .	28·00	28·00	1·00
Kingsmill, Q.C. 221	24·00	48·00	2·00
Little Marvel, Q.C. 233 . . .	8·00	32·00	4·00
Little Wonder, G.M.L. 136 . .	344·00	2,507·27	7·05
Mundalla, Q.C. 215 (G.M.L. 103) .	213·30	1,121·70	5·25
Triple Alliance, Q.C. 196 . . .	10·00	50·00	5·00
Yes-No, Q.C. 218 (G.M.L. 90) . .	32·00	99·50	3·10
Sundry Claims	499·90	1,049·88	2·10
Total . . .	3,802·30	8,925·52	2·32

The above figures may not accurately represent the total yield from the Middle and Sandy Creek centres, owing to the fact that it has not been possible to satisfactorily separate the returns of sundry claims from those credited to the adjoining centre of Nullagine.

General.—The Mosquito, Sandy, and Middle Creek districts are embraced within a mineral belt which extends from Nullagine to Mosquito for a distance, as shown by the official maps of the Mines Department, L. 76, L. 77, of about 24 miles. Over the whole distance numerous quartz reefs outcrop over a belt of about a couple of miles or so in width. Many of these reefs have been opened up at one time or another and worked, although a good deal of the work cannot be regarded as having been systematically carried out. None of the workings which were accessible to me had reached anything like 200 feet in depth. An examination of such of the mines as were open to my inspection demonstrated that the deposits gave every promise of being permanent, though they naturally varied in their dimensions and richness in different portions. According to the official figures, it appears that the country between Mosquito and Castle Creek has yielded gold to the extent of 19,157·41 ozs., which has been extracted from 8,872·24 tons of quartz, being at the average rate of 2·16 ozs. per ton; from these figures it will be seen that some high-grade ore has been raised, though it must be remembered that, under the conditions prevailing, only rich ore can be mined at a profit. Of the 57 [1] crushings recorded from the district lying between the two localities, it appears that 7 yielded under 1 oz. of gold to the ton, 24 up to 2 ozs., 11 up to 3 ozs., 8 up to 4 ozs., and the remaining 7 fluctuated between 5 ozs. and 9 ozs.

CRUSHING FACILITIES.—The present crushing facilities in the district of Mosquito, Sandy, and Middle Creeks comprise the Barton Mill at Middle Creek, the Parnell Battery, owned by the Bell Exploration Company at Mosquito, and the Royer's Public Crushing Battery on M.A. 6, Mosquito Creek. What is known as the Lady Ray Battery was originally erected on M.L. 5, at the 20-mile Sandy, and crushed for the public during the years 1900 and 1901. This battery was subsequently removed, and is now stored at the Barton, and may possibly be erected in conjunction with the present mill, if developments at the mine so warrant.

The Barton Battery is available for crushing at the following rates: For parcels up to 20 tons, 35s. per ton; and 30s. per ton for anything over that. During the three years ending 1903, it appears that the public stone crushed at the Barton Mill practically equalled that from the Company's own lease, or, approximately, about 50 tons per month.

The Lady Ray Battery, originally located on M.L. 5 at 20-mile Sandy Creek, crushed for the public during the years 1900 and 1901 647·85 tons of stone, which yielded 981·54 ozs. of gold, or about 27 tons per month.

The Royer's Public Crushing Battery treated, since it was erected in 1900, 1893·10 tons of stone, with a yield of 2928·95 ozs. of gold, or about 52 tons per month.

The Parnell Battery, according to the official statistics, crushed 120·50 tons of public stone, and returned 221·45 ozs. of gold, or roughly, about 10 tons per month. Under an agreement recently entered into with the Government, the owners of the battery have received State aid in consideration of the mill being available for public crushing during a stipulated number of days per month, at the following rates: For less than and not exceeding 50 tons, 30s. per ton; and for anything over 50 tons, 25s. per ton. This rate is the lowest in the district at the present time for parcels over 50 tons.

There is no question that could crushing be carried out at lower rates than those at present prevailing, stone that must, under present conditions, be left would be raised and milled, for a few shillings less for crushing (and carting) makes all the difference between profit and loss.

It was pointed out to me by a deputation, consisting of representatives from the prospectors and leaseholders which waited upon me by request at 20-mile Sandy, that all the gold in the ore treated at the different private crushing plants was not recovered, that this represented a considerable loss to them, and they urged the establishment of a properly equipped State mill.[1] Upon this point I am not in a position (for obvious reasons) to throw any other light than to merely draw attention to the returns obtained at the Lambert's Treatment Works, M.A. 41, where certain tailings from the district have been cyanided:—

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[1] Taking the annual return from each mine or claim as representing one crushing.—A.G.M.

Table showing the Yield of the Tailings cyanided at Lambert's Treatment Works.

Year.	Tailings Cyanided.	Gold therefrom.
	Tons.	Ozs.
1902	1960	1259·05
1903	840	379·45
Total . .	2800	1638·50

Owing to the way in which the returns are furnished, it has not been possible to separate the yield of the tailings from each centre. These data, so far as they go, show *primâ facie* that the statement regarding the loss of some of the gold is based upon reasonable grounds.

Two assays of tailings from this neighbourhood have been made in the Survey Laboratory, and gave the following results:—

4518 .	. Gold .	. 1 oz. 8 dwts. 20 grs. per ton.
169B .	. Gold .	. 19 dwts. 14 grs. per ton.

The initial figures refer to the numbers in the laboratory sample book.

TIMBER.—The supply of timber for mining purposes is not, over this portion of the district, abundant, and, having regard to future serious mining operations, may practically be said to be non-existent. Wood for fuel is mostly to be obtained from the banks of the water courses traversing the district, and at the present time, owing to the diminution of the supply in close proximity to the workings, much greater distances have to be traversed to obtain it.

WATER SUPPLY.—Over the whole district between Mosquito and Nullagine it cannot be said that the water supply is good. Wells sunk in the granite area of Mosquito yield practically no supply unless after heavy rains. This rock not being, below the level of the weathered zone, sufficiently porous to allow of the absorption and transmission of water, and even at greater depths likely to be more compact owing to pressure, &c., there is but little hope of increasing the supply from this source by either the deepening of the existing wells or the sinking of others. Fissures, either joints, faults, or bedding planes, may, of course, allow the water to be carried below the weathered zone, or the level of permanent saturation; but the chances of a well or bore hole striking such a fissure are so small that any expenditure incurred in the hope of increasing the supply by such means could hardly be expected to prove successful.

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[1] A report upon this question has been submitted, and will be found *in extenso* in the Annual Report of the Geological Survey for the year 1903.—A.G.M.

The strata of the other portions of the district are affected by weathering to such an extent as to allow of the percolation and transmission of water to depths depending, amongst other causes, upon the nature of the individual rocks. Some of the weathered portions of the sandstones and grits associated with the schists are eminently suited for the absorption and transmission of water.

A good supply of water occurs in the old water shaft on the Machine Area at Sandy Creek, and might be made available for public use after the officers of the water supply department have satisfied themselves that the supply would be adequate to meet the drain upon it. Whether any supply so obtained would be likely to be suitable for domestic use depends upon the fact that any water which percolates beneath the surface dissolves the soluble constituents to an extent which would appear to depend on the composition of the rock it traverses, the depth and the time it remains confined. Many of the schistose rocks in the area in question are of such a composition as would naturally cause any water traversing them to become mineralised to such an extent as might render it unsuitable for domestic use. On the other hand, the quartzose, sandstone, grits, and allied rocks associated with them are of such a character that any water falling upon and being absorbed by them would naturally be expected to be, at any rate, relatively free from mineral impurities.

Boring or sinking for water, if intelligently carried out, having due regard to the geological conditions prevailing, may be reasonably expected to result in obtaining supplies at any rate suitable for such requirements as do not entail what may be called a constant draft upon the supply.

CARTAGE.—It may be noted in this connection, Mr. Downes, the Public Works District Engineer, writing in 1890 upon the "40-mile Country" (*i.e.* the country between Nullagine and Mosquito Creek), remarked:—

> "As a general rule, tracks for carting are fairly easy to find through the country, and are usually fairly level, and nearly always have a hard and fairly even surface; yet the great distances that have to be traversed to the only battery working, together with the uncertainty of horse feed and water supply, render carting at present so costly an item that in the more distant parts of the district it takes 1½ ozs. and even 2 ozs. per ton to pay cartage, crushing, purchase of explosives, &c., the men only commencing to make wages when the grade of the stone is above this percentage. The consequence is that, generally speaking, nothing under 2 ozs. per ton reefs are at present worth touching, and all reefs of lower grade than this are left severely alone, though, with improved facilities, these comparatively low-grade ores will prove a great source of wealth in the future. Stores and material are almost entirely carted from Port Hedland to Nullagine, a

distance of 183 miles, of which 70 miles near the coast is very heavy, and some little of the remainder is rough and rocky. . . ."[1]

The above description sets forth the condition of affairs as it appeared in 1899, and at the present time practically the same may be said to prevail. To Nullagine and the Mosquito Creek neighbourhood cartage costs at the present time from about £17 to nearly £20 per ton.

I.—The Moolyella Tinfield

(*With a Geological Sketch Map.*)

The Moolyella Tinfield, as defined by the authorities, is situated on the relatively high granite tableland, drained by the head waters of Brockman's Creek, Talga River and their tributaries, all of which fall into the Coongan River. The principal productive area embraces about 9 square miles of country, and is depicted on the geological sketch map attached.

History.—Tin appears to have been first discovered in this locality in the year 1898, and the samples submitted to this office assayed 68·1 per cent. of metallic tin. During this year the production amounted to 75·45 tons, valued at £4419. During the year 1899 considerable progress appeared to have been made in the exploitation of the tin field, in that during that period 42 leases, embracing an area of 1181 acres had been taken up, and of these 1059 acres are stated to have been actually worked. The amount of tin reported only totalled 57·50 tons, valued at £3612; of this, however, only 29·55 tons, valued at £2025, were exported from the State during the year. There seem to be good grounds for believing that the quantity of tin reported does not actually represent the total production for the district during the year. The year 1900 showed a marked increase in the output of black tin, owing to the fact that the tinfield was worked during the whole 12 months. The official records show that black tin to the extent of 387·87 tons, valued at £27,174, was officially reported to the Government, but the Warden, in his report for the year 1900, states that—

> "As there were a number of alluvial diggers working who obtained tin of which no return can be got, the total output must have been larger."

Of the quantity of black tin recorded from Moolyella during 1900, it appears that only 368·34 tons, valued at £30,146, was exported from the State. During 1901 very few tin mining leases appear to have been worked, most of the ground being held as claims, and despite this the output of black tin showed a marked increase, for 412·98 tons, valued at £21,148, were raised. The year 1902 showed a noticeable decrease in the output of black tin from the Moolyella centre, there being only 104·55 tons of ore, valued at

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[1] Annual Report of the Department of Mines for the year 1899. Perth: By Authority, 1900, p. 146.

£7407. A slight increase in the output for the year 1903 is recorded, there having been reported 569·28 tons, valued at £37,885.

GENERAL GEOLOGICAL FEATURES

The Moolyella Tinfield presents a remarkable uniformity in its geology, the whole area being formed of a granite, composed of quartz, felspar, and mica. The granite covers a very wide expanse of territory, extending over an area of about 900 square miles, in the country lying to the east of the Coongan River, to the west of the Nullagine, and to the south of what may be called the Marble Bar-Yandicoogina auriferous zone. A similar area of stanniferous granite occupies the country to the west of the Coongan River, and included within its boundaries the tin-mining centres of Cooglegong, Wodgina, and the Shaw, which will form the subject of examination next season.

The granite of the Moolyella type often passes into a very coarse-grained rock [5398], containing quartz, mica, and felspar.

The granite, as may be seen by an inspection of sections along its margin, is clearly intrusive, for it has eaten its way into the schists, and in the vicinity of Bamboo Creek it sends veins and bosses into them.

The age of the granite cannot yet be definitely ascertained, although it passes beneath the sedimentary beds of Bamboo and Yandicoogina, which, according to the meagre evidence available, are inferentially assumed to be Cambrian.

As may be seen by an inspection of the geological map, the Moolyella granite is traversed by several north and south quartz reefs, some of which are over 50 chains in length, and a series of pegmatite (?) [5397] veins. These pegmatite veins exhibit, when laid down upon a map, a general parallelism; they trend gradually north and south, conforming in this respect to the strike of the quartz reefs.

The upheaval of the granite mass, and the stresses and strains resulting therefrom, induced along an axis, having north and south direction, has resulted in the production of a series of joints, &c., which has formed the channels up which mineral-bearing solutions have percolated and deposited in the one place free quartz, forming the persistent reefs, and in the other have attacked some of the constituents of the granite. The result of this chemical action has been the production of a rock [5397] made up principally of quartz, albite, a little mica, together with a few garnets and cassiterite. The composition of the rock is shown in the table on page 7.

Deposits of this kind, which owe their origin to deep-seated causes, are as likely to be permanent as any ore deposits can ever be.

Practically all the tin hitherto obtained from Moolyella is derived from the alluvial deposits formed in the existing valleys, all of which are shown upon the geological map. As this portion of the field was practically a blank on the existing maps, it was found necessary to prepare a plan of the vicinity in which mining operations had been carried on. The work was carried out by means of a plane table and tape measure. The topographical and geological features are as accurate as the scale of the map, the time at my disposal, and the necessities of the work demanded.

The alluvial deposits do not attain any very great thickness, although in some places their width exceeds 10 chains. The tin ore found in the alluvium is very much waterworn and rounded [5399, 5400].

In addition to the alluvial deposits, a large quantity of residual tin, *i.e.* ore derived from the decomposition *in situ* of the tin-bearing pegmatites, occurs all over the field. This form of tin ore is very ragged and angular [5403]. Some very good prospects were obtained by Mr. Talbot, the Field Assistant, by dry-blowing the surface débris, along the face of an almost horizontal pegmatite vein, occurring about 16 chains west from the western boundary of the Independent M.L. 45. Careful search along the outcrop of the vein resulted in finding tin in the rock itself. These residual deposits, occurring as they do all over that portion of the granite area which is reticulated by pegmatite veins, afford a good standby for prospectors at such times as prospecting in other portions of the district becomes impossible. The occurrence of pegmatite veins over such a considerable portion of the granite *massif* leads to the conclusion that other alluvial and residual deposits quite as productive as any of those worked at Moolyella may yet be discovered, and there is every reason to encourage systematic and judicious prospecting, for some enterprising prospector may yet be rewarded by closer examination. The stream tin owes its origin to the disintegration of the granitic rocks, which form the matrices of the lode tin, using this latter term to denote the ore occurring in the parent rock as distinct from the detrital product.

Although the country rock contains tin, yet the lode tin is at present unworked, nor do any of the deposits yet noticed appear to contain a sufficiently high percentage of black tin to be payable. It is by no means impossible, considering the large area of what may be called stanniferous country, that deposits may yet be found that can be profitably mined.

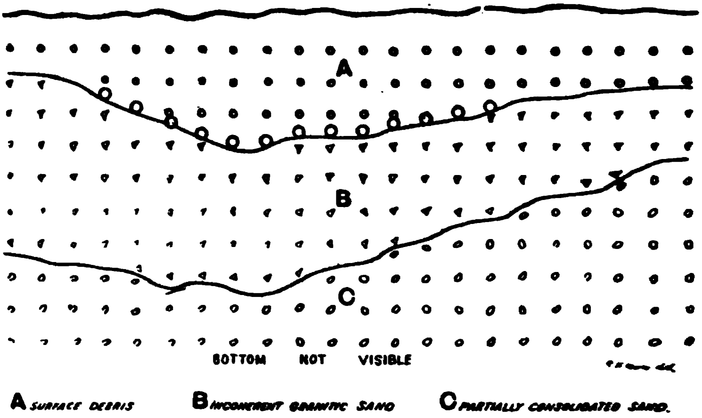
TIN-BEARING STREAMS.

The tin-bearing streams which, with their tributaries, are three in number, will be described in the following order :—

Prospector's Creek.
Meagher's Gully.
Moolyella Creek.

PROSPECTOR'S CREEK.—Prospector's Creek rises in the high ground originally embraced by M.L. 3, and after a generally westward course of about 25 chains (during which it is joined by two short tributaries flowing from the north and one from the south) it trends gradually north-westerly for about a mile and a quarter, and extends far beyond the limits of the map. The upper portion of the course of the creek flows over fairly rugged granite hills, which have yielded a fair quantity of residual tin. What was originally M.L. 3 is situated near the head of Prospector's Creek, and, as may be seen by an inspection of the tin workings shown on the geological map, appears to have been extensively worked. The workings are very shallow, the tin ore lying within a very short distance of the surface. A hole about 8 or 9 feet deep has been sunk in a gully which flows from the hills at a point about 20 feet west from the westernmost angle of M.L. 2, the section in which is depicted in Fig. 25.

FIG. 25.



SECTION OF WASH IN PROSPECTORS CREEK M.L.2 MOOLYELLA.

The granite bottom is not visible in the section. A well adjoining, 54 feet in depth, put down in the alluvial flat, reached the granite bottom at 8 feet from the surface. The situation of the well is evidently not in the channel of the old water-course.

The gutter in which the tin has been worked varies from 3 to 12 feet in width, and, so far as can be observed, nowhere exceeds 16 feet in depth. Prospector's Creek seems to have been extensively worked, and a good deal of tin obtained.

A tin-bearing dyke (?), consisting of a white rock, made up of quartz, felspar, a little mica (of a greenish hue), together with a few garnets, outcrops along the north side of the alluvial flat, traversing M.L. 2. This dyke contains coarse, angular tin, some pieces of which are nearly an inch in length. The dyke, which has been opened up for about 30 feet to a depth of about 4 feet, is about 2 feet in thickness, and has a general bearing of about 47 degrees. The dyke occurs in a fine-grained micaceous granite [5396]. The composition of the dyke [5397] is shown in the table on page 7. The felspar appears to be principally albite. About 40 tons of tin have been obtained from a pocket in the creek adjoining the dyke (?). Lower down the creek, at a point where it is crossed by a north and south reef, a considerable quantity of tin has been obtained, the quartz reef evidently acting as a bar which effectually prevented the detrital tin being washed down the river. The Independent M.L. 45, now abandoned, situated about 50 chains lower down the creek, has had a good deal of work done upon it, and about 15 tons of black tin, valued at £922, produced in 1900. It is almost impossible to arrive at the actual yield of the country drained by Prospector's Creek, owing to the way in which the returns have been kept.

MEAGHER'S GULLY.—Meagher's Gully lies about from 40 to 50 chains to the north of Prospector's Creek, and appears to have been extensively worked. The head of the gully rises to the north of M.L. 3, and flows northwards for about 50 chains parallel to a pegmatite dyke (?) which occupies the eastern bank of the gully. It is to the disintegration of this that the origin of the detrital tin from this portion of Meagher's Gully may be ascribed. This portion of the creek is embraced within the abandoned leases, M.Ls. 4 and 8. Near the northern boundary of M.L. 8 the gully makes a bend to the westward, and continues on this course for a distance of considerably over a mile, and extends far beyond the limits of the map. About 1 mile of the gully below M.L. 8 was at one time held under lease, M.Ls. 14, 16, 43, and 44. In the Old Sportsman lease, M.L. 46, upon which no work is at the present time being carried on, the tin wash is about 18 inches in thickness, and the payable portion averages about 8 to 10 inches in width; a thickness of about 3 feet of wash appears to be exceptional. The width of the alluvium in the lower reaches of the gully is as much as 10 chains, though the depth of detritus nowhere exceeds from 8 to 10 feet within the area of country examined.

Table showing the Tin Yield of Meagher's Gully.

Year.	Name of Lease.	Tin Ore Raised.	Value thereof.	Tin Ore Raised.	Value thereof.
		Tons.	£	Tons.	£
1899	Old Sportsman, M.L. 64	4·75	235	21·10	1195
1900	afterwards Sportsman, M.L. 16 .	12·35	740		
1901	,, ,, .	4·00	220		
1900	Huntsman, M.Ls. 43, 44	8·00	502	32·50	1827
1901	,, ,,	19·50	1008		
1902	,, ,,	5·07	317		
	Total			53·60	3022

The preceding figures give the yield of Meagher's Gully so far as may be gleaned from the individual returns of the leases as published in the latest mining statistics. These figures, however, do not by any means give the actual yield of the country drained by the gully, but as they show the returns from certain properties of which a record has been kept, they are on that account worthy of record.

This table does not embrace the yield of M.Ls. 4, 8, and 14, which is included in the published mining statistics under the general heading of the Marble Bar Syndicate property.

MOOLYELLA CREEK.—Moolyella Creek is the most important yet worked in the district, and drains the largest area of country. For about 2 miles and a half of its course, the creek has been held one time or another under mineral lease, but at the present time these have all been abandoned. Moolyella Creek is formed by the junction of three principal tributaries, which flow into one another in the vicinity of the Universal Extended Lease, M.L. 12, some little distance to the south of the Government Well. These tributaries are Swan Gully, Universal Gully, and what is known as Tin Creek.

Swan Gully rises in the very high and rugged country embraced within what was originally the Victoria Lease, M.L. 6, and traverses the adjoining Swan Lease, from which the watercourse takes its name, thence it joins the main channel a few chains to the north-west of the old Lady Vosper Lease. The whole length of its course drains granite country of the usual type. So far as may be judged by the statistics it appears that this gully has been responsible for 59·5 tons of ore, valued at £3692. The ground on what was originally M.L. 7 traverses granite country, intersected by north and south pegmatite dykes of the usual type; many of these are too small to be shown on the map. In the upper portion of the creek there is from only 18 inches to 2 feet of cover, but this increases gradually as the channel is followed down.

In what may be called Universal Gully, two or three pegmatite veins, underlying at a low angle to the eastward, traverse the valley. At one point on M.L. 15 a vein about 3 feet in thickness crosses the bed of the stream and forms a low ledge in the channel over which the water falls about 3 or 4 feet, when the stream runs. About 9 tons of black tin were obtained from a pocket just below the fall. Several dry-blowers were at work just below these veins and in almost every case were obtaining good, coarse angular tin.

The Government Well at Moolyella is situated on the Reserve originally embraced by M.L. 25 and yields a fair supply of water, which issues from the decomposed granite underlying the alluvium at a shallow depth. To the west of the well is an almost flat vein of pegmatite, about 3 or 4 feet in thickness, trending generally north and south; this vein is in all probability continuous with that which first makes its appearance in the Universal South, M.L. 50, about 70 chains southwards, near the head of the creek.

Five men were engaged at work on the A1 property, M.L. 23, at the date of my visit. A vertical shaft, 15 feet deep, bottomed after passing through 10 feet 6 inches of alluvium, on granite of the normal type. A good deal of water was obtained from the shaft; the water issued copiously from the decomposed granite below the bottom of the alluvium. The water was used for puddling. The average depth of the bottom in this creek for about a mile below the A1 is 8 feet and the width of the stanniferous wash varied from 15 to 60 feet.

Moolyella Creek has been practically worked from its source down to the Three Jacks M.L. 29.

The following table shows the yield of Moolyella Creek, so far as such can be ascertained from the official figures :—

Table showing the Tin Yield of Moolyella Creek.

Year.	Name of Lease.	Tin Ore Raised.	Value thereof.	Total Tin Ore Raised.	Total Value thereof.
		Tons.	£	Tons.	£
1899	Victoria M.L. 6	1·50	113	1·50	113
1899	Swan M.L. 5	8·50	575		
1900	,,	17·50	1,142	26·00	1,717
1900	Lady Vosper M.L. 13	32·15	1,862	32·15	1,862
1900	Mandalay M.L. 11	1·10	71	1·10	71
1899	Universal M.Ls. 10, 12, 15, 18, 31	5·10	309		
1900	,,	46·60	4,071	51·70	4,380
1899	O.K.M.Ls. 20, 21, 23	11·20	795		
1900	,,	39·05	2,486		
1901	,,	52·75	2,752	103·00	6,033
1900	Three Jacks M.L. 29	2·25	158	2·25	158
	Total			217·70	14,334

This table does not include the yield from M.Ls. 7 and 9, which is embraced in the published mining statistics under the general heading of the Marble Bar Syndicate's property.

SUMMARY.—All the tin ore hitherto obtained from Moolyella is of detrital origin; the detrital tin has been derived from the disintegration of pegmatite veins traversing the granite, and is of distinctly local origin. The stream tin is practically worked out, whilst residual or surface tin may be found wherever the pegmatite veins are numerous.

The following table shows the yield of the Moolyella Field:—

Synoptical Table showing the Yield of the Moolyella Tinfield.

Name of Creek, &c.	Tin Ore Raised.	Value thereof.
	Tons.	£
Prospector's Creek	15·00	922
Meagher's Gully	53·60	3,022
Moolyella Creek.	217·70	14,334
Not specified[1]	569·28	37,885
Total	855·58	56,163

From these figures, which have been taken from official sources, it appears that a considerable quantity of black tin has been produced from Moolyella. The modern alluviums and the residual deposits have been extensively worked and yielded the whole of the output. The richness however of these superficial deposits is no proof of exceptionally rich lodes or veins beneath, for owing to the difficulty with which tin is acted upon by atmospheric agencies extending over untold periods, it may by a process of natural concentration gradually accumulate in much greater quantities than it existed in the parent rock. Lode tin is known to occur in the field though the deposits have not been worked, owing presumably to their low grade; but deposits may yet be met with of sufficient richness to be remunerative, and there is every encouragement to search for them.

[1] This includes the yield of the different leases of the Marble Bar Syndicate property, which, owing to the way the returns have been supplied, it has not been possible to allocate to the different creeks.—A.G.M.

APPENDIX I

Descriptive Register of Specimens from the Pilbara Goldfield, 1903

Registered No. of Specimen.	Registered No. of Microscopic Section.	Name.	Locality.
5395	497	Granite (decomposed)	Golden Granite Reef, Boodalyerri
5396	485	Granite	M.L. 2, Moolyella
5424	...	Decomposed Granite with quartz leaders	Golden Granite Lease, Boodalyerri
5426	484	Granite	Mosquito Creek
5384	439	Amygdaloidal Rhyolite (?)	Six miles above the North Pole, Shaw River
5392	443	Felsite (?)	Duffer's Creek, near Marble Bar
5397	486	Pegmatite	M.L. 2, Moolyella
5398	...	Coarse Pegmatite	M.L. 2, Moolyella
5404	444	Quartz Felsite	West side of Bamboo Creek, near Post Office, Bamboo
5417	480	Quartz Felsite	Elsie Road at Nullagine (De Grey) Crossing
5416	...	Felsite (?)	Elsie Road at Nullagine (De Grey) Crossing
5411	478	Granitic Schist	Eastern Mine, G.M.L. 451, Yandicoogina
5379	437	Diabase (?)	Trig. Station 6
5405	445	Dolerite (Diabase ?)	Bulletin Mine, G.M.L. 161, Bamboo Creek
5407	476	Greenstone	Cairn A, Yandicoogina
5425	483	Volcanic Ash (?)	Near Martin's (Boodalyerri), Little River
5377	435	Foliated Greenstone	Hills, near Box Soak
5375	433 434	Serpentine (?)	Hills, near Box Soak
5382	...	Weathered Schist	Lalla Rookh
5380	438	Quartzite	Gorge Camp, Strelley River
5387	...	Conglomerate	Mount Hogback, Shaw River
5388	442	Fine-grained Sandstone	Mount Hogback, Shaw River
5408	477	Fine-grained Sandstone	Yandicoogina
5419	481	Limestone	Near Mount Elsie, Elsie Creek
5420	482	Limestone	Carawine Pool, Oakover River
5422	...	Chalky (?) Limestone	Carawine Pool, Oakover River
5378	436	Laminated Chert (Quartzite)	Poonthanna Hill, Turner River
5381	...	Quartz	Bergamina, G.M.L. 606, Lalla Rookh
5383	...	Quartz	Alma North G.M.L. 602, Lalla Rookh
5385	440	Banded Chert	Ridge, Shaw River
5386	441	Chert	Ridge, Shaw River
5389	...	Green Quartz	Talga Talga
5390	...	Reef Quartz	Talga Talga
5391	...	Quartz	Main Reef, Talga Talga

Descriptive Register of Specimens from the Pilbara Goldfield—continued

Registered No. of Specimen.	Registered No. of Microscopic Section.	Name.	Locality.
5393	...	Jasper	Near Marble Bar (with magnetite crystals)
5394	...	Jasper	Shaw River
5399	...	Tin Ore	Messrs. McDonald's lease, Moolyella
5400	...	Deep Ground Tin	Moolyella
5401	...	Surface Tin	Moolyella
5402	...	Tin Ore	Moolyella
5403	...	Tin Ore	Moolyella
5406	...	Iron Ore	Just-in-Time, near Marble Bar
5409	...	Quartz	Black Shepherd Reef, G.M.L. 544, Yandicoogina
5410	...	Quartz	Eastern Reef, G.M.L. 451, Yandicoogina
5412	...	Quartz	Granite Reef, Yandicoogina
5413	...	Quartz	Lady Adelaide Reef, G.M.L. 249, Yandicoogina
5414	...	Quartz	Invincible Reef, G.M.L. 557, Yandicoogina
5415	...	Quartz	Uncle Tom Reef, G.M.L. 250, Yandicoogina
5418	...	Quartz	Elsie Reef, G.M.L. 86, Mount Elsie
5421	...	Chert in Limestone	Carawine Pool, Oakover River
5423	...	Chert in Limestone	Carawine Pool, Oakover River
5427	...	Gold in Quartz	Parnell North, G.M.L. 102, Mosquito Creek
5428	...	Gold in Quartz	Off Chance, G.M.L. 128L, Mosquito Creek
5429	...	Gold in Quartz	Barton Reef, G.M.L. 106, Middle Creek
5430	...	Quartz	Barton Reef, G.M.L. 106, Middle Creek
5431	...	Copper-bearing schist	Strelley Reef, G.M.L. 84, Middle Creek

1904.

WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 16.

THE
MINERAL PRODUCTION
OF
WESTERN AUSTRALIA
UP TO THE END OF THE YEAR 1903,

BY

A. GIBB MAITLAND,
Government Geologist,

AND

C. F. V. JACKSON,
Assistant Geologist.

Issued under the authority of the Hon. H. Gregory, M.L.A., Minister for Mines.

WITH A MAP.

PERTH:
BY AUTHORITY: WM. ALFRED WATSON, GOVERNMENT PRINTER.

1904.

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Map of Western Australia showing Goldfields, Mining Districts, and Distribution of Useful Minerals } At the end.

PREFATORY NOTE.

THE contents of this report are substantially a reprint (brought up to date) of an article on the Mineral Production of Western Australia up to the end of 1901, which was contributed by myself to the official Year Book for 1900-1901, but which, however, was not published until late in the year 1903.

It being readily understood that information of the nature embodied in this report loses a considerable portion of its interest and value if, by delay in publication, it is allowed to become a matter of ancient history, the Minister for Mines ordered the publication of the data annually as one of the Bulletins of the Geological Survey.

This publication records the development of the mineral resources (using the term in its widest sense) of the State up to the close of the year 1903.

The statistics are, as usual, derived from official sources, and may therefore be accepted as authentic records.

A map showing the Goldfields and Mining Districts of the State, as well as the known distribution of the useful minerals, is attached, in order to render the descriptive portions of the text more intelligible.

A. GIBB MAITLAND,
Government Geologist.

Geological Survey Office,
Beaufort Street, Perth,
1st May, 1904.

The Mineral Production of Western Australia up to the end of 1903.

SUMMARY.

The mineral products of Western Australia, though greater by several million pounds in their annual value, exhibit less variety than those of any of the other Australian States; hence a comparison of the mineral section of our imports and exports indicates in some measure the direction in which the State's resources have yet to be developed.

The total value of the mineral products of the State up to the end of 1903 was £47,779,376, and the value of the production during 1903 was £8,972,024, which, as compared with £8,094,826 during 1902, is a gain of £877,198 for the year.

The total annual value of the products has shown a substantial gain each year over the preceding one for the last three years, the highest gain being attained in 1901, when the increase over 1900 exceeded £1,000,000, the exact figures being £1,260,927.

The metals and metalliferous minerals, since they include gold, make up by far the greater proportion of the value of the output, being over 98 °/₀ of the total; and in fact, as well as a somewhat limited variety, there has been comparatively only a very moderate contribution from non-metalliferous minerals.

Fuels are limited to coal, the total production of which to date amounts in value to £306,424, while the value for 1903 was £69,128, as compared with £86,188 for 1902. This is a slight decrease, which was due to labour troubles, of short duration, affecting the Collie Proprietary Co., the largest producer.

The value of coal imported into the State during 1903 was £69,636; coke and patent fuel also forming an item of considerable value amongst the imports. Petroleum and natural gas have as yet not been produced in the State.

Structural materials, such as building stone, clays, etc., have, unfortunately, not so far been included in the statistical tables of production; but both are augmented to some extent by imports of slates, tiles, etc. The whole of the cement for structural purposes is imported.

Grindstones, oilstones, emery, ~~etc.,~~ also only appear on the import list, though abrasive materials are not altogether without place in the mineral resources of the State; and considerable deposits of infusorial earth have recently been surveyed.

Chemical materials are limited, so far as production is concerned, to salt, but workable deposits of gypsum have been located from which possibly an output may soon be recorded.

Miscellaneous products comprise asbestos, graphite, limestone, precious stones, etc., as well as guano and artesian water, which, though not, strictly speaking, mineral products, are herein included on account of their importance to the State, and these, excepting of course the latter, amounted in total value of production, at the end of 1903, to £349,225. The contribution from guano was by far the largest, while of the others, except for limestone for fluxing purposes, amounting to £12,298, the value has been very insignificant.

Statistics of mineral production, and, as far as the available records will admit, statistics of imports and exports for the last five years, are given in detail in the following chapters, dealing specially with the respective products; and also in the appendix.

The following table is a summary of the total quantity and estimated value of the mineral products of the State (including guano) up to the end of 1903.

Summary of the total Quantity and Value of the Mineral Products of Western Australia (including guano) up to the end of 1903.

Product.	Quantity.	Estimated Value.
METALS AND METALLIFEROUS MINERALS.		£
Gold (export and * mint)	10,933,141†	46,441,031§
Copper (ore raised)	48,914‡	269,412
Tin (ore raised)	4,995‡	288,172
Lead (ore exported)	33,644‡	364,756
Lead (pig exported)	684‡	13,306
Silver (exported)	341,024†	39,546
Silver-lead (ore raised)	57‡	429
Iron (ore raised)	50,792‡	33,871
Antimony (ore exported)	22‡	230
Cobalt (ores exported)	2‡	41
NON-METALLIFEROUS SUBSTANCES.		
Coal (raised)	568,401‡	306,424
Plumbago (ore exported)	1‡	6
Limestone (flux and building stone raised) ...	58,090‡	12,298
Precious Stones (exported)...	||	1,024
Mica (exported)	||	294
Asbestos (exported)	||	11
Salt (raised)	3,318‡	8,525
Guano (exported)	86,165‡	335,592
TOTAL VALUE	...	48,114,968

* Since May, 1899. † Ounces fine. ‡ Statute tons.
§ Includes value of gold coined at Mint. || Not stated.

PART I.

METALS AND METALLIFEROUS MINERALS.

GOLD.

General.—The auriferous deposits of Western Australia have been responsible up to the end of December, 1903, for the production of 10,933,141ozs. of fine gold, valued at £46,441,031, which figures include the whole of the raw gold entered for export, from the time of the first gold discovery in 1886, and also of that treated at the Perth Mint from its opening in 1899, which has either been exported or used for local purposes.

The metal has been found to occur under several different conditions, viz.:—

(1.) Native metal.
(2.) Compounds with tellurium and other elements.
(3.) Associated with other minerals.

(1.) Native gold has been recognised in several different varieties, the names by which they are known being generally descriptive of their outward appearance—thus, crystalline gold, dendritic gold, rough gold, flake gold, mustard gold, sponge gold.

(2.) Compounds with tellurium and other elements occur at Kalgoorlie and several other mining centres, but the latter have not, so far, been of much importance; being chiefly antimonial, arsenical, and bismuthic compounds. Tellurides of gold, however, are of more importance, and occur at Kalgoorlie and Mulgabbie, and at the former place, Boulder, more freely and in larger masses than in other known occurrences.

The most frequently occurring mineral is calaverite, whilst petzite, goldschmidtite, and two new minerals, Kalgoorlite and Coolgardite, have also been found in several of the mines.

(3.) Of the metallic minerals which are found to accompany gold in Western Australia, by far the most important is iron pyrites, which, with its concomitant oxides of iron, is found in every ore body from Kimberley to Dundas. Not only is this mineral found in close conjunction with free gold, but in many instances, such as at Red Hill (Coolgardie Goldfield), is itself found to carry a considerable amount of gold imperceptible to the naked eye. As a rule, the pyrites does not constitute more than four or five per cent. of the gangue, but at some mines in Menzies and Mt. Ida, amongst other places, it forms one-half or more of the latter.

Next in order of importance after pyrites is galena. It occurs in the gold reefs of Hall's Creek, Brockman's, and all the other Kimberley centres; but it is found that the richer the stone in galena, the poorer the gold. Galena also occurs in conjunction with gold at Tambourah and Horseshoe.

Vanadinite has been detected with gold at Coolgardie and Pinyalling.

Arsenopyrite accompanies gold at Ruby Creek, Niagara, and Coolgardie. Some beautiful specimens of this mineral have been obtained from Bayley's United Gold Mine, at Coolgardie. They consist of veined arsenopyrite, traversed in every direction by a network of veins of gold, varying in width from 1-20th of an inch down to a microscopic thickness.

Zinc Blende is an indication of rich ore at Yandicoogina, Coolgardie, and Lawlers; in each instance, however, forming a very small proportion only of the total gangue.

Native bismuth and bismutite are found in auriferous quartz at Burbanks, Dundas, Yalgoo, and Lawlers. At Burbanks the native bismuth is alloyed with gold to the extent of about one per cent. The bismuth at Lawlers is also, in all probability, alloyed with gold, since the surrounding scales of bismutite are thick with fine scales of metallic gold.

Pyrrhotite occurs in the quartz reefs of Southern Cross and Burbanks, in neither of which instances is it nickeliferous.

Chalcopyrite and copper carbonates occur in association with gold at Coolgardie, Sir Samuel, Tambourah, Hall's Creek, Gorge Creek, and many of the Murchison centres.

Bournonite is of frequent occurrence in the beds at Kalgoorlie, and is also said to accompany gold at Wiluna.

Native copper is reported from Coolgardie, Sir Samuel, and Roebourne.

Scheelite occurs in bunches in auriferous reefs at Coolgardie and Southern Cross, but in both instances is characteristic of poor ore.

Of the earthy secondary minerals which accompany gold in Western Australia, quartz is the most important here, as elsewhere. Gold occurs in veins of calcite, more or less magnesian, at Mary River, Panton River, Kalgoorlie, Kanowna, and Red Hill (Coolgardie Goldfield). Chalcedony occurs in many quartz veins and is characteristic of much of the better ore at Donnybrook. Gold has been found in gypsum at the Island, Lake Austin, and is of frequent occurrence in the oxidised zone at Kalgoorlie. Actinolite, chlorite, and other minerals derived from the enclosing rock mass are found in many quartz reefs, but probably owe their origin to agencies other than those which caused the deposition of the gold, and are for that reason of little interest.

Purity of Western Australian Gold.—Mr. Wallace, the Statist to the Department of Mines, estimates the average fineness of the gold produced during 1903 at ·8379, of a value of £3 11s. $2\frac{1}{4}$d. per oz. So many impurities may, however, be added to, or removed from the gold during the process of extraction from its ores, that these figures give only a very crude idea of the average composition of the native metal. That its fineness varies very largely in different parts of the State, and follows no rule as to latitude or longitude, is shown by the analyses in the table below, all of which were made on carefully-cleaned specimens of the native metal.

Composition of Native Gold.

Nature of Gold.	Locality.	Specific Gravity.	Gold.	Silver.
			%	%
Small alluvial nuggets ...	Hall's Creek, Kimberley	16·62	93·30	6·60*
Three-ounce alluvial nugget	do.	16·80	88·39	11·61
"Bobby Dazzler" nugget ...	Shark's Gully, Pilbara	14·66	76·81	23·04†
Gold from quartz boulders	Talga, Pilbara ...	16·20	84·46	15·54
Gold from conglomerate ...	Nullagine, Pilbara ...	...	91·21	8·79
Gold from quartz reef ...	Bamboo Creek, Pilbara	...	94·00	6·00
Do. do.	Toweranna, Pilbara ...	...	94·53	5·47
Do. do.	Peak Hill, Peak Hill	17·16	96·54	3·46
Do. do.	Nannine, Murchison ...	15·75	89·45	10·50
Sponge gold from lode ...	Boulder, Kalgoorlie, East Coolgardie	...	99·91	·09
Coarse gold from ironstone pebbles	Block 50, Coolgardie ...	18·91	99·46	·64
Crystalline gold from calcite vein	Red Hill, Coolgardie ...	18·00	93·21	6·72
Gold from alluvial	Preston River, South-West	...	92·90	7·10
Electrum from quartz reef ...	Donnybrook, Donnybrook	...	49·29	50·71

* Also contained ·10 % Copper and Iron. † Also contained ·15 % Copper and Iron.

Gold Matrices.—Over the auriferous area of the State, the ore deposits naturally fall into two classes:—

(*a.*) Primary deposits embracing lodes, veins, stockworks, dykes, lode formations, shallow impregnations of surface material, and all deposits in which concentration has been subsequent to the formation of the enclosing rock.

(*b.*) Secondary deposits embracing all alluvial deposits, residuary soils, gravels, and other deposits in which the gold has been concentrated by mechanical action contemporaneously with the formation of the rock itself.

The deposits included in class (*a.*) are of chief importance, the annual production therefrom in 1903 comprising 99 per cent. of the State's total.

They are found chiefly in amphibolites or hornblende schists, but chloritic schists of somewhat doubtful origin frequently constitute the enclosing rock mass, and sometimes, in the Northern parts of the State, mica schists, slates, and quartzites or sandstones.

From the figures available the following table is the nearest approach to a statement of the annual production of gold from this class of deposits:—

*Annual Gold Yield from treatment of Ore raised.**

Year.	Quantity.	Year.	Quantity.
	ozs.		ozs.
Previous to 1897 ...	†569,093·02	1900	1,486,227·62
1897	630,311·96	1901	1,821,582·83
1898	967,044·73	1902	2,101,408·42
1899	1,550,424·44	1903	2,320,673·26

Total to end of 1903 ... ... **11,446,766·28**

* Excludes alluvial gold; includes gold contained in quartz specimens. † Alluvial not separately reported previous to 1897.

The deposits included under class (*b.*) are of less importance, and from their derivation, in most cases the result of decomposition of gold-bearing rocks *in situ*, of less permanence. The production therefrom, largely the result of the operations of Dry-blowers, is also a somewhat ephemeral quantity.

The table shown on p. 14 gives the annual production of alluvial gold, as reported to the Mines Department.

Annual Production of Alluvial Gold, as reported to the Mines Department.

Year.	Quantity.	Year.	Quantity.
	ozs.		ozs.
1897*	12,353·92	1901	19,915·49
1898	74,667·08	1902	15,832·59
1899	50,338·48	1903	14,751·89
1900	27,689·46		

Total to end of 1903 ... ... **215,548·91**

* Not separately recorded previous to 1897.

The crystalline rocks—the matrices of the auriferous deposits—are divided into three broad parallel belts, formed of granite, gneiss, and schist, which trend generally north-west and south-east. Observations have shown that there are two fairly well-defined and more or less continuous ore-bearing belts, which have a distinct relation to the geotectonic features of the crystalline rocks. The schists, which constitute the principal auriferous belts, form long and comparatively narrow bands or attenuated elliptical patches. The schists consist of mica, chlorite, sericite, hornblende, and quartz, and serpentinous schists, together with hematite-bearing quartzites.

All the important auriferous areas occur within the limits or in the immediate vicinity of country occupied by the schistose rocks. These auriferous belts occupy a very large area of country, extending from the South Coast to the country lying between Spit Point and Cape Lambert, on the North-West Coast—extending over about 14 degrees of latitude. The auriferous belts exceed 20 miles in width in places.

There is a larger area of auriferous country exposed at the surface than in any other portion of Australasia, and since the relations which the auriferous deposits, one of the factors of the State's prosperity, bear to the broader geological features naturally take a prominent place in any account dealing with its mineral resources, the method adopted in the following pages has been to embody a brief *aperçu* of the salient features, in a separate description of each of the nineteen goldfields into which the auriferous area of the State has, for convenience of administration, been divided.

The information available, however, for the above purpose is, in one or two cases, more fragmentary than could be wished. It has been found most convenient to adhere to a strictly geographical order in description, beginning with the field at the northern extremity of the State. The description of each field is followed by a table, giving the yield of gold as shown by *(a.)* the figures furnished to the Department of Mines, and by *(b.)* the data in the archives of H.M. Customs House. It will be noticed that in all cases there is a difference between the two sets of figures. Up to the end of 1903 there have been officially reported to the Mines Department 11,662,315ozs. of gold from the various fields of the State; the Customs and Mint authorities, however, give 12,410,774ozs. as that entered for export, being 748,459ozs. in excess of the figures furnished to the Mines Department. The discrepancy is to be partly accounted for by the difficulty experienced in obtaining a record of the alluvial gold, and also by the fact that a good deal of the gold won in the early days was probably never officially reported. Writing in 1899, the Warden of Yilgarn notes, with reference to the output of gold from that district, that "a good deal of gold leaves the field and is not recorded."

Total Production of Gold from the respective Goldfields, as reported to the Mines Department, and as entered for Export and received at Perth Mint.

Goldfield.	Reported to Mines Department.	Entered for Export and received at Perth Mint.	
	Gross weight.	Gross weight.	Fine contents.
	ozs.	ozs.	ozs.
Kimberley...	16,275·23	27,631·50	24,687·13
Pilbara	119,383·34	208,810·39	185,886·47
West Pilbara	12,803·81	14,952·27	12,960·75
Ashburton...	7,096·68	5,535·30	4,946·24
Gascoyne	524·82	691·80	613·07
Peak Hill	188,846·59	168,781·19	148,444·81
East Murchison	440,829·53	421,440·57	369,839·19
Murchison...	1,067,473·06	1,219,226·27	1,073,335·38
Yalgoo	55,152·91	42,660·22	37,989·28
Mt. Margaret	916,745·95	915,929·90	803,473·82
North Coolgardie...	913,694·66	903,115·47	793,629·46
Broad Arrow	236,267·69	196,325·97	174,023·26
North-East Coolgardie	597,122·13	448,390·43	397,549·67
East Coolgardie	5,846,949·10	6,134,610·34	5,394,803·09
Coolgardie	724,256·52	1,068,987·89	949,634·66
Yilgarn	241,896·36	339,869·90	302,214·86
Dundas	257,367·12	258,724·84	228·675·50
Phillips River	16,935·57	17,517·07	14,946·86
Donnybrook	1,141·88	946·65	839·74
Goldfields generally	1,552·24	16,625·64	14,647·69
Total	11,662,315·19	12,410,773·61	10,933,140·93

KIMBERLEY GOLDFIELD.

The most northerly goldfield in the State is that of Kimberley, and associated with its discovery in 1882 are the names of Mr. E. T. Hardman (then Government Geologist), Messrs. Hall and Slattery, and Phil. Saunders.

The goldfield, which embraces an area of 33,000 square miles, was proclaimed on the 20th May, 1886. The boundaries, as defined by amendment gazetted on the 31st of October, 1902, to take effect from the 1st of November of that year, are as follows:—

> Commencing at the intersection of the 129th meridian of east longitude with the 16th parallel of south latitude; thence south along 129th meridian to 19 degrees 30 minutes south latitude; thence west along said 19 degrees 30 minutes south latitude to the 126th meridian; thence north along 126th meridian to the 18th parallel of south latitude; thence north-easterly to the point of commencement.

The strata exposed on the goldfield consist of Crystalline Schists of Archæan Age, together with representatives of Cambrian, Devonian, and Carboniferous systems, as well as a large development of volcanic rocks.

The *Crystalline Schists* and allied rocks, the matrices of the metalliferous deposits, are highly developed in Kimberley. They consist of micaceous and talcose schists, gneiss, and granite. They have been proved to extend from near Denham River to Mount Dockrell, and appear again in the Mueller Range, a little further west; and, striking north-westwards, pass through the King Leopold Range to King Sound. This belt of rocks varies in width from 10 to 30 miles, and has been proved to have a horizontal extent of at least 120 miles, and probably continues much further.

Mining operations on the Kimberley field have been chiefly confined to six principal centres, viz.:—The Panton, Hall's Creek (the official centre of the field), Brockman's, Ruby Creek, the Mary River, and Mount Dockrell.

During the last few years the number of miners and diggers on the field has varied from 10 to 12, and there has been very little change in the condition recorded since 1900, except the fluctuations of a small output. After dropping to a very low limit in 1902, the gold yield showed a slight increase during 1903, and the production of alluvial gold was 197ozs.

Up to the end of 1903 the Kimberley field yielded, according to the Mines Department figures, 16,275ozs. of gold; the Customs authorities, however, report that up to the same date 27,631ozs. were entered for export. There is thus a discrepancy of 11,356ozs. between the two different sets of figures. This difference may in all probability represent the yield of alluvial gold, which, unless under exceptional circumstances, was in the early days never reported to the Government.

The following table shows the annual yield of the Kimberley Goldfield from 1886 to 1903, as deduced from official data.

Yield of Kimberley Goldfield.

Year.	Ore Crushed.	Yield of Gold therefrom.	Gold Exported and received at Perth Mint.	
			Gross Weight.	Fine Contents.
	tons.	ozs.	ozs.	ozs.
1886	*a* 13,199·50	12,734·00	302·00	270·17
1887			4,873·00	4,359·37
1888			3,493·00	3,124·82
1889			2,464·00	2,204·28
1890			4,474·00	4,002·42
1891			2,699·62	2,415·07
1892			1,088·85	974·08
1893			1,621·70	1,450·77
1894			588·64	526·59
1895			876·68	784·27
1896			891·86	797·85
1897	383·50	229·30	554·07	495·67
1898	175·00	*b* 440·17	287·88	257·54
1899	694·00	*c* 917·15	1,122·81	1,004·46
1900	586·50	*d* 571·15	676·62	605·30
1901	185·00	*e* 297·06	663·37	601·26
1902	440·00	*f* 346·40	441·65	379·50
1903	890·00	*g* 740·00	511·75	433·71
Total	**16,553·50**	**16,275·23**	**27,631·50**	**24,687·13**

a Details not available. *b* Includes 310ozs. of alluvial. *c* Includes 417ozs. of alluvial. *d* Includes 331ozs. of alluvial. *e* Includes 164ozs. of alluvial. *f* Includes 151ozs. of alluvial. *g* Includes 197ozs. of alluvial.

PILBARA GOLDFIELD.

The Pilbara Goldfield was proclaimed on the 1st October, 1888, It embraces an area of 34,880 square miles.

Its boundaries, as defined by amendment gazetted on the 20th September, 1895, which took effect on the 1st November of that year, are as follows :—

> Bounded by a line starting from a point on the sea-coast eastward from Condon Creek, and extending through the summit of Poolingerena (or Mount Blaze) to a spot due north from the summit of Mount Macpherson; then south through the said summit to a spot due east from the summit of Mount Marsh, on the Upper Fortescue River; thence due west through the summit of Mount Marsh to the right bank of the Fortescue River, along it downwards to Survey Station V 23; thence in a northerly direction through Survey Station V32 to the right bank of the Cocreaca branch of the Yule River, and along the right banks of the Cocreaca Creek and the Yule River, downwards to the sea-coast, and along the sea-coast eastward to the starting point Excluding all townsites within the said boundaries.

What are believed to be the oldest rocks occurring in Pilbara are the granites and gneisses which form the platform upon which the newer formations were laid down. To these succeed the Greenstone schists and allied rocks, which occupy an extensive area of country, and which appear to be almost everywhere genetically connected with the occurrence of gold. Next in antiquity to the Greenstone schists comes the Nullagine Beds, which form a series of sandstones, grits, conglomerates, limestones, and associated igneous rocks. This formation is of importance in that near the base of the series some of the conglomerates have been worked for their gold contents.

There are eight principal mining centres on the goldfield, viz.:—Lalla Rookh, Talga Talga, Bamboo, Marble Bar, Warrawoona. Yandicoogina, Mosquito Creek, and Nullagine. The geographical position of the various mining centres suggests a zonal development of the auriferous deposits, full particulars in connection with which will be found in Bulletin No. 15.

The general direction of the belts almost everywhere coincides with the strike of the greenstone schists, which, when viewed broadly, is east and west. The width of the belts naturally varies. Quartz reefs occur in great abundance all through the schistose rocks, as well as to a more limited extent in the areas occupied by the granitic rocks. The quartz reefs are of two distinct types, viz., white quartz reefs and laminated quartz and jasper veins. The reefs invariably occur along the planes of foliation (? bedding) of the schists, or, at any rate, cut them at a very low angle. The reefs all carry rich shoots of gold, but when these became poor, operations ceased, for owing to the economic conditions prevailing only the richest ores can be worked at a profit. The auriferous ores are, with one exception, all of such a character, as render them readily amenable to battery amalgamation and cyanidation.

At Nullagine is a conglomerate, near the base of the series which has been worked latterly by the British Exploration Company. Crushings from the outcrop have yielded as much as 2ozs. to 4ozs. of gold to the ton; a trial crushing, however, of 777 tons yielded, in September, 94·10ozs. of gold, being at the rate of less than two pennyweights per ton. The gold, which seems to occur in well-defined bands, seems to be of a secondary nature. In some respects this conglomerate bears a close resemblance to those auriferous conglomerates of the Rand in South Africa, better known perhaps as banket deposits.

The gold yield from the Pilbara field, as reported to the Department of Mines, up to the end of 1903 has been 119,383·34ozs. obtained from the milling of 54,883·95 tons of ore, thus giving an average yield of 2·17ozs. per ton. It is unlikely that the high average of the last few years will be maintained under existing conditions; there is, however, a fair extent of low-grade ore deposits not yet developed, which, under more suitable conditions, might be turned to profitable account, for the deposits give every indication of being permanent.

During the year 1903 the output was 11,330ozs., or 7 per cent. less than the previous year; the decrease being due to the rainfall having fallen somewhat below the average, resulting in a scarcity of water for crushing purposes.

The following table shows the annual yield of the Pilbara Goldfield from 1889 to 1903:—

Yield of the Pilbara Goldfield.

Year.	Ore Crushed.	Yield of Gold therefrom.	Gold Exported and received at Perth Mint.	
			Gross Weight.	Fine Contents.
	tons.	ozs.	ozs.	ozs.
1889	11,121·10	[b] 28,470·56	[a]11,170·00	9,992·63
1890			[a]16,055·31	14,363·01
1891			[a]11,875·00	10,623·32
1892			[a]12,892·80	11,533·84
1893			[a]11,698·50	10,465·43
1894			[a]16,254·50	14,541·20
1895			[a]19,522·40	17,464·65
1896			[a]11,810·11	10,565·27
1897	5,138·70	6,825·26	[a]11,955·87	10,695·67
1898	6,719·75	[c] 14,413·79	11,662·56	10,433·27
1899	7,567·55	[d] 19,291·98	20,526·20	18,362·65
1900	6,173·71	[e] 16,616·85	17,140·51	15,333·82
1901	5,414·11	[f] 10,264·32	11,320·40	10,260·43
1902	7,163·38	[g] 12,170·46	10,706·03	9,199·50
1903	5,585·65	[h] 11,330·12	14,220·20	12,051·78
Total	**54,883·95**	**119,383·34**	**208,810·39**	**185,886·47**

[a] Includes export from West Pilbara. [b] Includes 2,082ozs. from unknown tons. [c] Includes 2,000ozs. of alluvial and 102ozs. dollied and specimens. [d] Includes 2,608·29ozs. alluvial and 833·72ozs. dollied and specimens. [e] Includes 1,527·54ozs. of alluvial and 88·92ozs. dollied and specimens. [f] Includes 1,050·55ozs. of alluvial and 275·52ozs. dollied and specimens. [g] Includes 679·05ozs. of alluvial and 41·37ozs. dollied and specimens. [h] Includes 1,180·48ozs. of alluvial and 741·97ozs. dollied and specimens.

WEST PILBARA GOLDFIELD.

The West Pilbara Goldfield, 9,480 square miles in extent, originally included in the Pilbara Goldfield, was created a separate field by proclamation gazetted on the 20th of September, 1895, to take effect from the 1st November of that year.

The authorities define the boundaries as follows:—

> The portion of Crown lands bounded by a line starting from the sea-coast, at the mouth of the Fortescue River, and extending along the right bank of the said river upwards to Survey Station V23; thence in a northerly direction through Survey Station V32, to the right bank of the Cocreaca branch of the Yule River, and along the right banks of the Cocreaca Creek and the Yule River, downwards to the sea-coast, and along the sea-coast westwards to the starting point.

The mining centres of this field are Croydon, Hong Kong, Lower Nicol, Mallina, Pilbara, Toweranna and Weerianna.

The total production, as reported to the Mines Department, was, up to the end of 1903, 12,803·81ozs. The output dropped to a very insignificant amount in 1901, but during 1902 and 1903 there has been a rather remarkable increase.

The following table shows the annual yield of the West Pilbara Goldfield from 1889 to 1903:—

Yield of the West Pilbara Goldfield.

Year.	Ore Crushed.	Yield of Gold therefrom.	Gold Exported and received at Perth Mint.	
			Gross Weight.	Fine Contents.
	tons	ozs.	ozs.	ozs.
1889 to 1896	160·00	337·91	*a*	*a*
1897	608·85	860·06	*a*	*a*
1898	202·30	326·70	2,028·27	1,814·48
1899	879·85	*b* 1,934·80	1,955·51	1,749·39
1900	681·15	*c* 953·65	721·68	645·61
1901	48·00	*d* 231·29	480·86	435·84
1902	1,279·00	*e* 2,223·09	3,284·37	2,822·20
1903	4,673·00	*f* 5,936·31	6,481·58	5,493·23
Total	**8,532·15**	**12,803·81**	**14.952·27**	**12,960·75**

a Previously shown in the Pilbara (*vide ante*). *b* includes 735·07ozs. of alluvial. *c* Includes 357·46ozs. of alluvial. *d* Includes 136·34ozs. of alluvial and ·45ozs. dollied and specimens. *e* Includes 907·61ozs. of alluvial and 3·18ozs. dollied and specimens. *f* Includes 372·16ozs. of alluvial.

ASHBURTON GOLDFIELD.

The Ashburton Goldfield was proclaimed on the 11th December, 1890.

As at present constituted, it embraces an area of 14,252 square miles. Its boundaries, defined by amendment gazetted on the 18th October, 1901, to take effect from the 14th of that month, are as follows:—

Bounded by lines starting from the summit of Mt. De Courcey; thence east by south to the summit of Mt. Wall; thence about south-east by east to Trig. Station $\overset{\triangle}{10}$; thence about south-east by south to the summit of Mt. Bresnahan; thence south-west by south 37 miles along the north-west boundary of Peak Hill Goldfield; thence by a line running about north-west by west to the summit of Mt. Palgrave; thence southerly along the west boundary of the Gascoyne Goldfield about 17 miles; thence due west, passing through Trig. Y2, about 56½ miles; thence due north about 113¼ miles to a point due west of a point 7½ miles north of Trig. Station on Red Hill; thence due east, passing through aforesaid point, about 77½ miles to a point due north of Mt. De Courcey; thence south about 49¼ miles to the starting point.

This field is situated on the Ashburton River, and extends from a point 150 miles from its mouth for 150 miles inland. The Ashburton River, for the most part, flows over large alluvial plains, with low ridges of clay, slate, and quartz out-cropping here and there, and flat-topped ranges away to the south; but in one place, called the Gorge, the hills close in upon the river, which then flows in a deep rocky channel for the space of a few miles.

Most of the gold workings lie on the southern side of the river, the only exception being the "Dead Finish." Until quite recently all the work on this field was alluvial digging, but a few leases on reefs are now held, the alluvial diggings being almost deserted.

The field consists of seven mining centres, viz.:—Main Camp, Dead Finish, Star of the West, Top Camp, The Gorge, Mount Mortimer, and New Find.

The auriferous belt of country extends from the junction of the Hardey River with the Ashburton, a little to the north-east of Mount Clement, following the latter river in a south-east direction for about 150 miles. It is bounded on the south by the Barlee Range and a flat-topped tableland, which follows, at a distance of 14 miles to the south, the main course of the river. To the north it extends across the Ashburton and Hardey Rivers to Mount Wall and Mount De Courcey, a distance, in a northerly direction from the river, of from 20 to 30 miles, giving an auriferous area of about 10,000 square miles.

The total gold reported to the Mines Department up to the end of 1903, was 7,096·68ozs., which was almost entirely the product of alluvial mining. The value of the annual output for the last three years has remained almost stationary, and the mining centre of Mount Mortimer has been responsible for by far the greater proportion.

The following table shows the annual yield of the field up to the close of 1903:—

Yield of the Ashburton Goldfield.

Year.	Ore Crushed.	Yield of Gold therefrom.	Gold Exported and received at Perth Mint.	
			Gross Weight.	Fine Contents.
	tons.	ozs.	ozs.	ozs.
1891	*a*	*a*	838·72	750·31
1892	*a*	*a*	·70	·63
1893	*a*	*a*	467·74	418·43
1894	*a*	*a*	285·27	255·20
1895	*a*	*a*	540·76	483·76
1896	*a*	*a*	669·17	598·64
1897	...	*b* 302·95	1,038·18	928·75
1898	...	*c* 500·63	449·88	402·46
1899	...	*d* 1,659·10	521·30	466·36
1900	...	*e* 1,704·00	524·36	469·09
1901	...	*e* 992·00	63·92	57·94
1902	...	*e* 978·00	...	...
1903	...	*e* 960·00	135·30	114·67
Total	...	7,096·68	5,535·30	4,946·24

a No detailed records given. *b* 105·95ozs. alluvial and 197ozs. dollied and specimens. *c* 434·63ozs. alluvial and 66ozs. dollied and specimens. *d* 1,582·10ozs. alluvial and 77ozs. dollied and specimens. *e* Alluvial.

GASCOYNE GOLDFIELD.

This goldfield, which embraces an area of 5,061 square miles, was officially proclaimed on the 25th of June, 1897, the proclamation to take effect from the 15th April of that year. The boundaries are thus defined by the authorities:—

> Starting from the summit of Mount Palgrave, and extending about south-east by south to a point situate 37 miles from the summit of Mount Bresnahan in direction of Trig. Station K20; then about south-west by south to the said Trig. Station K20; thence about south-west to the summit of Mount Gascoyne; thence about north-west by north to the summit of Mount Agamemnon; thence northward to the summit of Mount Palgrave, the starting point.

The field, though geographically distinct, has been placed under the charge of the same Warden as the Ashburton.

Prospecting operations are chiefly confined to the neighbourhood of Bangemall, the official centre of the field, but no details as to the nature and mode of occurrence of the ore deposits are available.

The yield of this goldfield, as can be seen by the official figures appended, was, up to the close of 1903, small.

Yield of the Gascoyne Goldfield.

Year.	Ore Crushed.	Yield of Gold therefrom.	Gold Exported and received at Perth Mint.	
			Gross Weight.	Fine Contents.
	tons.	ozs.	ozs.	ozs.
1897	1·35	[a] 13·55	[e]	[e]
1898	...	[b] 13·50	[e]	[e]
1899	235·35	[c] 333·77	418·72	374·59
1900	...	[d] 74·00	86·10	77·02
1901	...	[d] 90·00	25·83	23·41
1902	...	...	124·86	107·29
1903	...	...	36·29	30·76
Total	**236·70**	**524·82**	**691·80**	**613·07**

[a] Includes 6·80ozs. dollied and specimens. [b] Dollied and specimens. [c] Includes 119·43ozs. of alluvial. [d] Alluvial. [e] Details not available.

PEAK HILL GOLDFIELD.

The Peak Hill Goldfield, which comprises an area of 12,194 square miles, was established by proclamation gazetted on the 19th of March, 1897, to take effect from the 1st April of that year. The authorities define its boundaries as follows:—

> The portion of Crown lands bounded by lines starting from an angle in the northern boundary of the Murchison Goldfield, at the summit of Mount

Hale, and extending along the said boundary in an east-south-easterly direction to another angle at the summit of Mount Russel; thence due north to the north-easterly corner of the East Murchison Goldfield, latitude being on the 26th parallel of south latitude; thence in a northerly direction to Trig. Station L15 on Wonyuegunna Hill; thence in a north-westerly direction to the summit of Mount Bresnahan, between the Angelo River and the Upper Ashburton; thence in a south-westerly direction to Trig. Station K20 on a peak near the source of the Lyons River; thence still south-westerly to the summit of Mount Gascoyne; thence south-south-easterly to the starting point on the summit of Mount Hale.

The goldfield includes within its boundaries the high ground lying at the heads of the Gascoyne and the Murchison Rivers.

By far the larger portion of the goldfield upon which mining operations of any scale are carried out consists of undulating country, situated on the lofty plateau drained by the heads of the Murchison and the Gascoyne Rivers.

The mines at Peak Hill are situated on a flat at the foot of a small quartzite hill, from which the place takes its name.

The country rock consists of banded, and in places granular quartzites (with secondary silica), mica schists, or quartzites. A remarkable feature are the masses, veins, or dykes of pure silica, which traverse certain portions of the field. In a few places these veins present the appearance of massive quartzite, but their mode of occurrence at angles transverse to the strike of the adjacent strata confute this view. In one of these mines a vein of this character is seen cutting across an auriferous quartz reef. The majority of the quartz dykes trend north-east and south-west, and preserve a wide parallelism. They are generally inclined at high angles, but not far from the vertical. They have not, however, proved to be remuneratively auriferous. The ore bodies consist of a mass of country rock, traversed by a network of interlacing veins of auriferous quartz, where the gold is not confined to the reef or veins, but appears to be disseminated through the decomposed country rock.

Resting upon the underlying rocks of the field is a variable thickness of recent superficial deposits. These consist of loose gravel or loam, from which gold is obtained by the usual method of dry-blowing. There is, unfortunately, no record as to what amount of gold has been obtained from this loose material, unless it is represented by the 3,349ozs. recorded in 1895.

This gravel reposes directly upon an irregular surface of an iron-stained cement, which rests upon an old eroded watercourse, and fills up all the inequalities in the latter, which, however, are of no great depth. In some cases erosion has succeeded in cutting down the cement to bedrock, and exposing the underlying schists. Lithologically the cement is an ordinary conglomerate, formed by the mechanical action of water, and deposited in an old creek bed. The pebbles are embedded in a matrix of sand, formed of the comminuted remains of the underlying rocks. The component parts of the cement are in every way identical with those of the rocks at present outcropping, whilst the number of quartz pebbles are similar in character to the quartz forming those reefs by which the country rock is traversed. The gold in the cement is not exclusively in grains, scales, or nuggets, but is also found attached to its original quartz matrix. The official returns demonstrate that the amount of gold won from the cement has been considerable. As to whether the 4,551·60ozs. of gold returned, previous to 1897, from an unknown tonnage of quartz, were obtained from the cement or from the superincumbent loose gravel, the official data afford no clue.

At the present time mining operations are chiefly confined to the vicinity of Peak Hill, the official mining centre, and the Horseshoe Diggings, some miles to the north.

No discoveries of any importance appear to have been made during 1903, nor have any sensational finds been reported from any of the existing mines.

The State Battery has not been kept fully employed during the year, and during the six months it was kept running 1,011 tons of ore were crushed, yielding 972ozs. of gold, giving an average yield, per ton, of ·96ozs. The difficulty of obtaining firewood and mining timber appears to be felt, and must present a serious problem in the future if serious mining operations are to be carried out.

The progress of the field during the year 1903 has been somewhat disappointing, the gold yield, as reported to the Mines Department, having fallen to 35,656·08ozs., being 1,830·17ozs. less than the previous year.

The following table shows the yield of the goldfield up to the close of 1903:—

Yield of the Peak Hill Goldfield.

Year.	Ore Crushed.	Yield of Gold therefrom.	Gold Exported and received at Perth Mint.	
			Gross Weight.	Fine Contents.
	tons.	ozs.	ozs.	ozs.
1894 to 1896	1,043·85	*b* 11,070·16	*a*	*a*
1897	2,851·25	*c* 10,883·23	5,110·00	4,571·38
1898	4,018·09	*d* 14,969·32	13,736·85	12,288·93
1899	10,922·00	*e* 31,953·65	31,995·34	28,622·88
1900	16,254·60	*f* 26,571·63	28,669·86	25,647·93
1901	24,025·50	20,255·47	21,607·47	19,584·29
1902	57,494·25	37,487·05	32,737·17	28,130·48
1903	66,072·50	35,656·08	34,924·50	29,598·92
Total	**182,682·04**	**188,846·59**	**168,781·19**	**148,444·81**

a. Included in the Murchison export returns. *b*. Includes 4,551·60ozs. from unknown tonnage. *c*. Includes 399ozs. dollied and specimens. *d*. Includes 368·80ozs. dollied and specimens. *e*. Includes 478·90ozs. dollied and specimens. *f*. Includes 24·85ozs. dollied and specimens.

MURCHISON GOLDFIELD.

The Murchison Goldfield, as originally constituted, was first proclaimed on the 24th September, 1891; its boundaries were modified by proclamation gazetted on the 8th of February, 1895, to take effect from the 23rd January of that year. It embraces an area of 20,513 square miles. As defined by the authorities, the goldfield is—

> **Bounded by lines starting from the summit of Mount Murchison, and extending north-eastward to the summit of Mount Hale; thence east-south-eastward to the summit of Mount Russell; thence south-westward to the north-west corner of the Yilgarn Goldfield; thence west-north-westward to the summit of Wyemandoo Hill, and onwards to Trig. Station K6 on Goonahmoudey Peak; thence north-westward to the summit of Mount Farmer; and onwards to the summit of Mount Luke, and onwards to the summit of Mount Murchison.**

Along the principal belt of auriferous country on the Murchison Goldfield, the rocks for the most part strike a little to the westward of north, and underlie to the westward. The geological structure of the greater portion of the goldfield is remarkable for its uniformity, and may be described as a series of persistent zones of basic and ultrabasic rocks associated with schists and altered forms.

So far as observations have at present been carried, the latter appear to be merely sheared or metamorphosed varieties of the former "greenstones," which comprise diorites, pyroxenites, amphibolites, etc., and in one form or another constitute what may be called the auriferous series.

These zones of schists and greenstones are surrounded by granitic rocks, which vary considerably in character in different localities.

The greenstone schists are remarkable for their persistent strike and horizontal extent, one belt alone having an average width of 10 or 15 miles, having been proved to extend for at least 60 miles.

Detailed observations have so far, of necessity, been devoted rather to economic than to stratigraphical geology, hence the solution of the exact relation of the various rocks comprising the main group has not in all cases been completely determined.

It is quite conceivable that more detailed research than has hitherto been found possible would result in the recognition of highly metamorphosed sedimentary beds among the foliated greenstones. One of the most characteristic features of the whole Murchison Goldfield is the frequent occurrence of belts of banded hematite-bearing quartzites which extend as roughly parallel bands, often continuous for many miles in length; they are generally from two to four chains in width and outcrop in the form of rough serrated ridges. These bands are merely quartz reefs or lodes of a peculiar type, and are everywhere confined to the greenstones; they vary in composition from almost pure quartz, through varieties of banded jaspers often of great beauty, to practically pure banded hematite, some of which (probably those of the Weld Ranges) might, under more favourable conditions, be turned to profitable account as sources of iron ore. Since they are generally themselves auriferous, though, as a rule, of too low grade to be of any commercial importance under present conditions, they belong to the auriferous deposits of the field which, with the pure quartz reefs, are therefore of two distinct types.

The quartz reefs, in general larger in the northern portion of the field than in the southern, occur in the granite in addition to the greenstones and altered rocks, but it is only those in the latter that have proved to be auriferous to any extent. Sometimes they cross the banded lodes, and at the junction rich chutes are almost invariably found; these reefs, however, occurring in connection with the quartzites, though frequently of considerable size, are almost invariably very irregular and their gold contents very patchy, small rich chutes being obtained at their point of contact or intersection with the quartzites; the reefs of this class, therefore, are not of much use to a large company owing to the annual return being too uncertain.

The reefs which occur wholly in the greenstones and some distance from the quartzites, are, as a rule, much more regular both in size and in their gold contents, and, although the gold is very often found to occur in them in chutes, these are usually of considerable extent. The reefs, generally speaking, give every promise of living to a depth, and if a good many of them which are now abandoned were sunk on and systematically worked to a reasonable depth they would probably give very satisfactory returns. At present practically no work has been done in the North Murchison district below a vertical depth of about 300 feet.

The quartzites themselves are only in one or two localities rich enough to be worked as a body; they are, however, frequently traversed by transverse lines of faults, and along these rich pockets of stone are often found. The faults in some localities cross them almost at right angles, the chutes being generally of small, horizontal extent, and limited to the immediate vicinity of the quartzites.

For administrative purposes the Murchison Goldfield has been divided into four districts, viz., Nannine, Cue, Day Dawn, and Mount Magnet.

The total production of the field, as reported to the Mines Department up to the end of 1903, was 1,067,473ozs. Marked progress has been made by the Murchison Goldfield during the last three years, each year showing a large increase over the preceding one, and the output for 1903 amounted to 241,791ozs., which is an increase of 15 per cent. over that of 1902.

The most important mine is the Great Fingall, the output of which for 1903, being 157,272ozs., is 65 per cent. of that of the whole field. It is expected that great benefit will be derived from the completion recently of the railway to Nannine.

The following table gives the yield of the goldfield since the date of opening up to the close of 1903:—

Yield of the Murchison Goldfield.

Year.	Ore Crushed.	Yield of Gold therefrom.	Gold Exported and received at Perth Mint.	
			Gross Weight.	Fine Contents.
	tons.	ozs.	ozs.	ozs.
1891	110,805·00	*a* 140,432·28	2,064·43	1,846·83
1892			24,356·47	21,789·19
1893			21,210·45	18,974·77
1894			52,946·32	47,365·54
1895			65,477·26	58,575·66
1896			71,282·69	63,769·17
1897	72,003·80	*b* 62,316·19	82,891·85	74,154·67
1898	92,255·80	*c* 79,256·39	93,667·16	83,794·22
1899	66,696·87	*d* 80,548·71	93,518·03	83,660·80
1900	96,791·03	*e* 105,722·31	108,696·58	97,239·47
1901	113,213·43	*f* 146,591·93	144,693·86	131,145·66
1902	153,142·51	*g* 210,813·86	212,570·34	182,657·99
1903	189,945·13	*h* 241,791·39	245,850·83	208,361·41
Total	894,853·57	1,067,473·06	1,219,226·27	1,073,335·38

a Includes 2,340ozs. dollied and specimens and 1,072ozs. from unknown tons. *b* Includes 1,041·67ozs. dollied and specimens. *c* Includes 1,119·12ozs. dollied and specimens. *d* Includes 199·13ozs. of alluvial and 2,844·50ozs. dollied and specimens. *e* Includes 512·85ozs. of alluvial and 3,273·29ozs. dollied and specimens. *f* Includes 1,412·07ozs. of alluvial and 856·86ozs. dollied and specimens. *g* Includes 1,021ozs. of alluvial and 154·65ozs. dollied and specimens. *h* Includes 1,460·85ozs. of alluvial and 868·75ozs. dollied and specimens.

EAST MURCHISON GOLDFIELD.

The East Murchison Goldfield was originally proclaimed on the 28th June, 1895, but, for administrative purposes, its boundaries were altered by proclamation gazetted on the 28th March, 1902, to take effect from the 2nd April, 1902, so as to embrace an area of 28,144 square miles, which is thus defined by the authorities:—

Bounded by lines starting from the southernmost corner of the Murchison Goldfield, situate about four and a-half miles east and about four miles south from Trig. Station K75 on Wyemandoo Hill, and extending east to a spot about 15 miles east and about 44 miles north from the summit of Mt. Ida; thence north about four and a-half miles; thence east about 67¼ miles; thence north about 14 miles; thence east about seven miles; thence north to the 26th parallel south latitude; thence west to a spot due north of the summit of Mt. Russell; thence south to the said summit of the said Mt. Russell; thence south-south-westward along the eastern boundary of the Murchison Goldfield to its southernmost corner, the starting point.

Observations made in the East Murchison Goldfield have shown that granite is the staple formation, which has been invaded by dykes and masses of some basic rock, together with a much later series of intrusions of acidic rocks, which usually form narrow tortuous dykes. Near the junction of the basic rocks and the granite a strong development of hornblende, mica, and iron-bearing quartz schists are of frequent occurrence. These schists are seen to pass gradually into granite in such a way as to suggest that they may be merely highly metamorphosed forms of the latter. These crystalline rocks are covered by sandstones, quasi-vitreous sandstones, and conglomerates, which have been classed, inferentially, as of Mesozoic Age. Of a much newer date than these are the deposits of ironstone gravel which cover such an extensive area of country. The origin of these, however, is not quite understood. Their largest development occurs to the west of the Montague Range, which is made up of iron-bearing quartz schists of the type so prevalent in the Mt. Hale district.

There are now 11 mining centres on the East Murchison Goldfield, viz., Lawlers, Lake Darlôt, Mt. Sir Samuel, Lake Way, Black Range, Cork Tree, Kathleen Valley, Mt. Clifford, New England, Wilson's Creek, Wilson's Patch.

At Lawlers the reefs are said to occur along the zone of contact between the gneissic granite and diorite schists. The reefs have a general east and west trend, and can be followed along the surface for considerable distances.

The Mt. Sir Samuel mining centre is situated at the southern end of the Violet Range, immediately to the north of Lake Miranda. Geologically, this range is a diorite boss, occurring in massive granite, of a similar nature to the granite of Lake Way. Breaking through the diorite boss, usually in an east and west direction, are numerous granite dykes of apparently a later age. They are particularly conspicuous on the sides of Mt. Goode, where they can be traced for considerable distances. In close association with these dykes are some very large quartz reefs, which latter, as far as surface indications show, follow the strike of the dykes with great persistency. At McDonough's Lookout, another apparently disconnected diorite boss is found, with numerous granite dykes intruding it, and the associated quartz reefs. The granite dykes in this locality are coarse-grained, and can clearly be seen to consist of quartz, orthoclase felspar, and mica. The mica, however, occurs in two forms, the Muscovite (common white mica) and Lepidolite (lithia mica). The quartz reefs at McDonough's Lookout are of the white opaque barren variety, and will scarcely recommend themselves to prospectors. Included in the quartz are large irregular mangano-ferruginous nodules in considerable quantity. In addition to the reefs associated with the granite dykes other quartz reefs are found in the massive diorite. These latter, for the most part, though sometimes rich in gold, are lenticular, and too expensive to work or prospect for in the hard diorite rock. Besides the quartz reefs, there is one example of a fissure lode being worked, viz., at the Belle Vue mine.

The mining history of the field has been one of steady progress, and during the last few years several new centres have sprung into existence; the most recent is that known as the Black Range, which appears to show some promise.

The production of the field during 1903 was 102,896ozs., and showed an increase of 13 per cent. over that of the previous year. The total output from the field up to the end of 1903 amounts to 440,829ozs.

The following table shows the yield of gold from the district since the opening of the field: —

Yield of the East Murchison Goldfield.

Year.	Ore Crushed.	Yield of Gold therefrom.	Gold Exported and received at Perth Mint.	
			Gross Weight.	Fine. Contents.
	tons.	ozs.	ozs.	ozs.
1896	1,467·00	*a* 2,576·00	...	...
1897	11,763·00	*b* 20,995·07	9,453·81	8,457·34
1898	31,947·99	*c* 37,080·32	39,563·35	35,393·19
1899	42,166·75	*d* 45,038·90	41,569·66	37,188·03
1900	56,923·00	*e* 64,698·03	58,369·50	52,217·09
1901	84,618·45	*f* 76,236·10	77,604·04	70,337·70
1902	138,137·75	*g* 91,308·85	91,976·45	79,033·73
1903	154,954·22	*h* 102,896·26	102,903·76	87,212·11
Total	**521,978·16**	**440,829·53**	**421,440·57**	**369,839·19**

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a. Previous to 1896 the returns were included in the Murchison Field, *vide ante*. *b*. Includes 621·18ozs. of alluvial and 443·17ozs. dollied and specimens. *c*. Includes 641·14ozs. of alluvial and 1,115·26ozs. dollied and specimens. *d*. Includes 1,628·22ozs. of alluvial and 1,485·38ozs. dollied and specimens. *e*. Includes 738·54ozs. of alluvial and 280·13ozs. dollied and specimens. *f*. Includes 203·79ozs. of alluvial and 447·25ozs. dollied and specimens. *g*. Includes 385·21ozs. of alluvial and 1,978·95ozs. dollied and specimens. *h*. Includes 640·93ozs. of alluvial and 641·50ozs. dollied and specimens.

MOUNT MARGARET GOLDFIELD.

This goldfield, which was previously included in the North Coolgardie Field, was declared by proclamation gazetted on the 12th March, 1897, to take effect from the 1st April of that year; its boundaries were amended by proclamation gazetted on the 28th of March, 1902, taking effect on the 2nd April, 1902, so as to embrace an area of 42,252 square miles.

The boundaries, as defined by the authorities, are as follows:—

Bounded by lines starting from a spot about 15 miles east and about 13 miles north from the summit of Mount Ida, and extending north about 35¼ miles; thence east about 67½ miles, passing through a tree marked "AN 33" at Doyle's Well; thence north about 14 miles; thence east about seven miles; thence north to the 26th parallel of south latitude; thence east to the 125th meridian east longitude; thence south to a spot due east of a tree marked "B 82" at Brickey's Soak; thence west through the said tree to a starting point. Excluding all townsites and fee simple lands within the boundaries.

This field is one of the most recently established goldfields, and is already one of the most important in the State.

Detailed geological observations have been carried out at several of the more important mining centres, but our knowledge of many portions of the field is somewhat meagre.

A very large portion of the surface of the ground is covered with a variable thickness of recent accumulations, derived from the disintegration of the underlying rocks; this forms the matrix of the alluvial gold.

The stable formation is granite, granitic gneiss, schists, and a series of basic rocks. The latter, comprising diorite, diabase, pyroxenite, etc., and the schists constitute the auriferous series, which here in some respects shows a resemblance to that of the Murchison Goldfield. The general strike of the schists is in a north-west direction, and they are often vertical or inclined at high angles.

There is here also a characteristic development of the banded quartz lodes or quartzites, which themselves are in some cases auriferous; but the hematite-bearing varieties are much more exceptional than in the case of the Murchison Goldfield. The other main types of auriferous deposits are the lodes or lode formations and pure quartz reefs, the latter often being of very large size; in such cases, however, there is a strong tendency to a lenticular form with no great horizontal extent.

Such lenses, quartz blows, often attain a great thickness in the widest portion, in one instance over 70 feet of solid white quartz. The most important quartz reefs are generally in the greenstones, but they occur also in the granite, and particularly at the junction.

The banded quartzites and lodes are confined to the greenstone, and many of the former stand up in bold relief and can be traced by the eye for many miles across country.

It is associated with one of these bands that the ore body of the Westralia Mount Morgans occurs.

The auriferous deposit of the Sons of Gwalia, another of the most important producers of the field, is of the type distinguished as lodes or lode formations.

The other more important mines are the Ida H. and Lancefield.

The field, for administrative purposes, is divided into three main districts, Morgans (the official centre), Laverton, and Malcolm (including Leonora). Besides the production of gold, the Mount Margaret field has also contributed a good deal towards the copper production of the State. The total gold production to the end of 1903 has been 916,746ozs., and during 1903, 212,490ozs., and the statistics show a record of steady progress.

A good deal of prospecting has been done within the last year, and promising reports have been received from the locality known as the Erlistoun, to the west of the more established centres.

The following table shows the yield of the Mount Margaret Field, since its inception, up to the end of 1903:—

Yield of the Mount Margaret Goldfield.

Year.	Ore crushed.	Yield of Gold therefrom.	Gold Exported and received at Perth Mint.	
			Gross Weight.	Fine Contents.
	tons.	ozs.	ozs.	ozs.
1895 to 1896	231·00	*b* 4,992·10	*a*	*a*
1897	13,198·74	*c* 22,592·09	8,685·73	7,770·22
1898	37,506·67	*d* 49,717·77	43,266 69	38,706·19
1899	75,586·35	*e* 79,923·72	81,817·07	73,193·17
1900	132,821·25	*f* 145,688·75	141,523·00	126,605·83
1901	246,578·00	*g* 190,032·15	198,807·70	180,192·63
1902	274,343·45	*h* 211,308·77	216,637·14	186,152·50
1903	270,797·33	*i* 212,490·60	225,192·57	190,853·28
Total	**1,051,062·79**	**916,745·95**	**915,929·90**	**803,473·82**

a Previous to 1897 included in North Coolgardie returns. *b* Includes 300ozs. dollied and specimens. *c* Includes 588·84ozs. of alluvial and 2,018·25ozs. dollied and specimens. *d* Includes 675·25ozs. of alluvial and 378·63ozs. dollied and specimens. *e* Includes 345·05ozs. of alluvial and 601·18ozs. dollied and specimens. *f* Includes 5·20ozs. of alluvial and 1,271·79ozs. dollied and specimens. *g* Includes 604·06ozs. of alluvial and 1,215·22ozs. dollied and specimens. *h* Includes 291·57ozs. of alluvial and 351·77ozs. dollied and specimens. *i* Includes 199·96ozs. of alluvial and 135·05ozs. dollied and specimens.

YALGOO GOLDFIELD.

The Yalgoo Goldfield was declared by proclamation gazetted on the 8th February, 1895, taking effect from the 23rd January of that year. Its boundaries, which enclose an area of 18,921 square miles, are thus defined by the authorities:—

Starting from the summit of Mount Murchison and extending west-south-westerly to the summit of Tallering Peak; thence south-easterly to the summit of Mugga Mugga Hill, and onwards to the summit of Mount Gibson, which lies about 12 miles south-west from Ningham Creek; thence eastward to Trig. Station K 83 on the west shore of Lake Moore; thence due east to the western boundary of the North Coolgardie Goldfield, and along it north to its north-west corner; thence north-westward to the summit of Wyemandoo Hill, and onwards to Trig. Station K 6 on Goonahmoudey Peak; thence north-westward to the summit of Mount Farmer, and onwards to the summit of Mount Luke, and onwards to the summit of Mount Murchison.

The mining centres of the Yalgoo field are Bilberaltha, Carlaminda, Field's Find, Gullewa, Kirkalucka, Noongal, Nynghan, Rothesay, Wadgingarra, Yalgoo, and Yuin.

The progress of this field has not been satisfactory, each year's output showing somewhat of a decrease; half the whole production, during 1903, of 3,842ozs. is accounted for by the output of one property, the Field's Find mine. The total production up to the end of 1903 has been 55,153ozs.

The following table shows the progressive yield of the goldfield up to the close of 1903:—

Yield of the Yalgoo Goldfield

Year.	Ore Crushed.	Yield of Gold therefrom.	Gold Exported and received at Perth Mint.	
			Gross Weight.	Fine Contents.
	tons.	ozs.	ozs.	ozs.
1895 to 1896	*a* 2,488·00	*a* 7,227·00	*b*	*b*
1897	3,666·97	3,455·79	2,034·23	1,819·81
1898	4,424·50	3,298·95	3,756·38	3,360·44
1899	17,933·51	*c* 12,135·94	10,879·58	9,732·83
1900	15,596·20	*d* 10,101·86	9,368·57	8,381·08
1901	13,117·30	*e* 9,238·25	9,198·51	8,337·22
1902	3,992·50	*f* 5,853·37	5,679·41	4,880·23
1903	2,412·00	3,841·75	1,743·54	1,477·67
Total	**63,630·98**	**55,152·91**	**42,660·22**	**37,989·28**

a Details not available. *b* Previous to April, 1897, included with Murchison. *c* Includes 16·50ozs. dollied and specimens. *d* Includes 289ozs. dollied and specimens. *e* Includes 12·06ozs. of alluvial and 4·90ozs. dollied and specimens. *f* Includes 13ozs. of alluvial.

NORTH COOLGARDIE GOLDFIELD.

This goldfield was proclaimed on the 28th June, 1895, its boundaries being subsequently amended by proclamation gazetted on the 12th March, 1897, to take effect from the 1st April of that year; it embraces an area of 30,609 square miles, and, according to the authorities, is circumscribed—

By lines starting from the southernmost corner of the Murchison Goldfield, being the south-west corner of the East Murchison Goldfield, and situate about 12 miles east and 5 miles south from Trig. Station K75 on Wyemando Hill, and extending south to the south-east corner of the Yalgoo Goldfield, which is a point due east from Mt. Gibson, near Lake Moore, and due north of a spot 10 miles west of a cairn on Yorkrakine Granite Rock; thence east-south-east to a point about 50 miles due west from a cairn marked NB1, near Wangine Soak; thence east to Survey Station NB1; thence about 87° 20 miles 22 chains to Survey Station R3; thence east to the 125th meridian east longitude; thence north along that meridian to a point east of a tree marked B82 at Brickey's Soak; thence west through the said tree to a spot about 76¼ miles west from it, and 13 miles north and 15 miles east from the summit of Mount Ida; thence north about 31 miles to the south boundary of the East Murchison Goldfield, and west to the starting point.

This field, which originally formed part of the Coolgardie Goldfield, has, for purposes of administration, been subdivided into the Menzies, Ularring, Niagara, and Yerilla districts.

In its geological structure, the field presents features which connect it geologically with those of Kalgoorlie and Coolgardie. The country rocks consist of granite, gniess, hornblende, mica, sericite, and serpentinous schists, associated with amphibolites, ferruginous quartzite, and diorite dykes. Felsite dykes have been noticed in some parts of the district. Ferruginous conglomerate, passing in places into pure limonite, occupies the caps of certain of the hills. All the rocks have suffered a considerable amount of decomposition, which extends to a depth of about 100 feet from the surface.

The lodes of Menzies, which are of a more or less schistose habit, have an approximate parallelism: they trend generally north-west, and have a fairly high underlie to the west. The gold occurs associated with iron, copper, and arsenical pyrites, galena (which is very abundant), and zincblende. Free gold occurs in the rocks within the zone of oxidation.

Mining is generally prosperous, but the outlying centres were somewhat hampered by want of water during the early part of the year.

The gold yield of 195,426ozs., during 1903, from this extensive field is the largest yet recorded and is an increase of 5 per cent. over that for the previous year; the total gold yield up to the end of 1903 amounts to 913,694ozs.

The following table shows the yield of the field up to the close of 1903:—

Yield of the North Coolgardie Goldfield.

Year.	Ore Crushed.	Yield of Gold therefrom.	Gold Exported and received at Perth Mint.	
			Gross Weight.	Fine Contents.
	tons.	ozs.	ozs.	ozs.
Previous to 1897 ...	14,265·30	*a* 26,962·85	*i* 17,160·51	15,351·71
1897	32,840·95	*b* 61,362·82	74,556·12	66,697·57
1898	42,032·79	*c* 72,878·88	70,625·32	63,181·09
1899	93,222·25	*d* 116,968·14	105,688·76	94,548·69
1900	90,727·99	*e* 106,773·97	106,193·38	95,000·12
1901	108,271·65	*f* 148,305·00	142,798·10	129,427·40
1902	156,325·07	*g* 185,016·58	187,272·79	160,920·24
1903	210,776·28	*h* 195,426·42	198,820·49	168,502·64
Total	**748,462·28**	**913,694·66**	**903,115·47**	**793,629·46**

a Includes 2,900·77ozs. dollied and specimens and 275ozs. from unknown tons. *b* Includes 120ozs. of alluvial and 391·12ozs. dollied and specimens *c* Includes 924·32ozs. dollied and specimens. *d* Includes 796·78ozs. of alluvial and 1,118·34ozs. dollied and specimens. *e* Includes 690·05ozs. of alluvial and 649·32ozs. dollied and specimens. *f* Includes 281·79ozs. alluvial and 969·62ozs. dollied and specimens. *g* Includes 281·57ozs. of alluvial and 901·60ozs. dollied and specimens. *h* Includes 232·98ozs. of alluvial and 2,204·34ozs. dollied and specimens. *i* Included with Coolgardie returns prior to 1st May, 1896.

YILGARN GOLDFIELD.

The Yilgarn field was proclaimed on the 1st October, 1888; its boundaries were amended by proclamation gazetted on the 20th March, 1896, taking effect from the 15th April of that year. It embraces an area of 15,593 square miles:—

Bounded by lines starting from a point 90 miles south of a cairn, H 26, on Koorarawalye Granite Rock, and extending west to a point due south of a point 10 miles west of a cairn on Yorkrakine Granite Rock; thence north to the south-east corner of the Yalgoo Goldfield; thence east-south-east to a point about 50 miles due west from a cairn marked NB (conjoined) 1, near Wangine Soak; thence south through the before-mentioned cairn H 26 to the starting point.

The occurrence of gold in what is now the Yilgarn Goldfield would seem to have been made known by Mr. Glass, of Mugakine, in the year 1887.

The principal mining centres of the field are Hope's Hill, Parker's Range, Southern Cross, and Mount Jackson.

The whole Yilgarn field seems to follow one anticlinal fold in the country, the centre of which is exposed at Golden Valley, where the reefs dip both east and west, where the country is hard and the stone carries much copper.

Hope's Hill and Southern Cross are on the western side of this fold, while Blackborne's is on the other side of a synclinal still further west, where the reefs dip to the east. All along this line of country the stone is highly mineralised, containing carbonate of iron and chlorite.

The output of the field for 1903 shows a slight increase over that of 1902, and there seems to have been a revival in activity; the population during the year increased by 28 per cent. The total yield of the field up to the end of 1903 amounts to 241,896ozs.

The following table shows the yield of the Yilgarn Goldfield up to the close of 1903:—

Yield of the Yilgarn Goldfield.

Year.	Ore Crushed.	Yield of Gold therefrom.	Gold Exported and received at Perth Mint.	
			Gross Weight.	Fine Contents.
	tons.	ozs.	ozs.	ozs.
1889	a174,925·00	b 94,194·60	1,858·50	1,662·61
1890			2,277·00	2,036·99
1891			12,833·30	11,480·61
1892			21,209·49	18,973·91
1893			75,744·55	67,760·73
1894			31,498·38	28,178·31
1895			19,747·75	17,666·25
1896			16,565·25	14,819·20
1897	35,988·00	17,072·82	17,994·48	16,097·78
1898	27,807·35	11,769·40	11,696·18	10,463·35
1899	33,403·18	16,371·78	16,805·04	15,033·71
1900	54,403·10	29,155·42	29,418·10	26,317·30
1901	26,529·00	c 26,587·41	29,488·07	26,727·00
1902	41,218·50	d 23,129·69	25,877·53	22,236·11
1903	50,623·50	e 23,615·24	26,856·28	22,761·00
Total	444,897·63	241,896·36	339,869·90	302,214·86

a Details not available. *b* Details not available, but includes 738·18ozs. dollied and specimens. *c* Includes 23·18ozs. dollied and specimens. *d* Includes 8·30ozs. of alluvial and 6ozs. dollied and specimens. *e* Includes ·50ozs. of alluvial and 211ozs. dollied and specimens.

COOLGARDIE GOLDFIELD.

The Coolgardie Goldfield was proclaimed on the 6th April, 1894; its boundaries were amended by proclamation gazetted on the 20th March, 1896, taking effect from the 15th April of that year. It embraces an area of 11,974 square miles, and is defined by the authorities as being:—

> Bounded by lines starting from the north-east corner of the Yilgarn Goldfield (which is a point about 50 miles west from a cairn marked NB1, near Wangine Soak) and extending south about 118 miles through a cairn H26 on Koorarawalye Granite Rock; thence east about 133 miles through the summit of a granite rock near the 50-Mile Soak, on the Dundas and Lake Lefroy Road; thence north about 48 miles to a point 35 miles east of the south-east corner of Hampton Plains Location 48; thence west 35 miles to the south-east corner of the above-mentioned Location; thence along the boundaries (surveyed) of Location 48, westerly 443 chains 91 links, northerly 564 chains 87 links to the south-east corner of Location 51; thence along the boundaries (surveyed) of that Location westerly 160 chains, southerly 60 chains, westerly 119 chains 87 links to the south-west corner of Location 51; thence northerly 400 chains along the westerly boundary of Location 51, and the eastern boundary of Location 53 to the north-east corner of Location 53; thence along a surveyed line 324° 16′ 36 miles 1,481 links; thence north 30 miles 47 chains 46 links along a surveyed line to a tree, R3, near Cane Grass Swamp on the 90-Mile Road; thence westerly about 50 miles to the starting point.

Previous to 20th March, 1896, the Coolgardie Goldfield embraced the present Coolgardie, East Coolgardie, North-East Coolgardie, and Broad Arrow Goldfields, all of which, together with the present Yilgarn field, were originally known as the Yilgarn Goldfield.

Coolgardie Goldfield, as at present constituted, was officially declared on the 20th March, 1896, and, for purposes of administration, was eventually divided into the Coolgardie and Kunanalling Districts.

The geological features of this area are marked by a mass of intrusive granite on the west, succeeded by a belt of hornblende and talcose schists, the whole being intersected by dykes of both basic and acidic rocks. The acid eruptive rocks, which, as a rule, follow the strike of the schists, in all probability emanate from the main granite mass, as cases occur in which a gradual passage from the latter can be identified. Quartz reefs are often intimately associated with the acidic dykes, and in some cases the latter gradually pass into pure quartz at their extremities. As a rule, these quartz veins are non-auriferous.

The schistose rocks, which are hornblendic, or occasionally talcose, seem to result from the surface weathering of amphibolites. The general strike varies from north 20° west and south 20° east to north 20° east and south 20° west, the dip being from 30° to 60° to the east; more rarely the beds dip west, but such is of local occurrence.

The diorites and andesites form both bosses and dykes, and are found invading both the granite and the schist.

In certain portions of the field both the granite and schistose rocks are covered with a variable thickness of their own weathered *débris* and other superficial deposits. These superficial deposits extend over a very large portion of Coolgardie; they vary in thickness from a few inches up to several hundred feet, as in Rollo's Bore.

Ancient water channels exist in the vicinity of Coolgardie, about eight miles from the township; one of these had been pierced by a bore to a depth of 162 feet.

The gold obtained from Coolgardie has been derived from three principal sources, viz., alluvial deposits, lode formations, and quartz reefs. The gold from the recent superficial deposits presents all the usual characters. Unfortunately there are no data available by which the amount of alluvial gold obtained in the early days from the Coolgardie Goldfield can be deduced. The "lode formations," as a rule, consist of schistose rocks traversed by a network of quartz leaders; the formations appear to possess no sharply defined boundaries, unless in exceptional cases, the limits of the deposits being defined by purely technical considerations. A great deal of gold seems to have been derived from these formations; but, owing to the way the returns are supplied, it has not been possible to separate the yield of the formations from that of the quartz reefs proper. The quartz reefs trend generally north and south, and have a dip of from 60° to 80° to the east.

Many of the quartz reefs in the neighbourhood of Coolgardie stand up from the surface like walls of masonry, 15 or 20 feet high, having resisted the denuding action of the atmosphere better than the enclosing country rocks.

There are two distinct varieties of reefs, one closely resembling the lode formations and occurring in large lenticular patches, often forming pronounced outcrops on the surface, and the other of the true fissure type. Of the first class, the reefs on Bayley's Reward Claim, and the Big Blow Mining Lease, No. 35, are the best examples, whilst Sherlaw's Perseverance, and Burbank's Birthday Gift Mining Lease, No. 3252, are examples of the second class.

The principal mining centres of the field are Bonnievale, Burbanks, Coolgardie, Gnarlbine, Londonderry, Red Hill, Widgiemooltha, Balgarrie, Carbine, Carnage, Cashman's, Dunnsville, Kintore, Siberia, and 25-Mile.

A decreasing tendency has been shown in the production of the field for several years, and the output, for 1903, of 84,303ozs. shows a decrease of four per cent. compared with that for 1902. The total gold reported to the Mines Department up to the end of 1903 amounts to 724,256ozs.

A State Battery is to be erected, which it is expected will improve results.

The following table shows the yield of the field up to the close of 1903:—

Yield of the Coolgardie Goldfield.

Year.	Ore Crushed.	Yield of Gold therefrom.	Gold Exported and received at Perth Mint.	
			Gross Weight.	Fine Contents.
	tons.	ozs.	ozs.	ozs.
1894	*a* 33,352·45	*a* 74,181·76	*b* 105,329·82	94,227·58
1895			125,105·94	111,919·21
1896			69,135·19	61,848·03
1897	54,251·16	64,791·48	104,306·37	93,312·00
1898	107,622·39	*c* 99,672·84	127,227·06	113,816·75
1899	154,893·14	*d* 126,290·04	141,170·08	126,290·11
1900	133,087·75	*e* 102,413·01	119,781·46	107,155·95
1901	121,646·91	*f* 84,744·43	88,600·54	80,304·56
1902	96,316·15	*g* 87,859·69	97,477·20	83,760·46
1903	105,825·58	*h* 84,303·27	90,854·23	77,000·01
Total	**806,995·53**	**724,256·52**	**1,068,987·89**	**949,634·66**

a Details not available. *b* Included with Yilgarn prior to 5th April, 1894. *c* Includes 52·71ozs. of alluvial and 1,158·96ozs. dollied and specimens. *d* Includes 1,562·95ozs. of alluvial and 1,713·54ozs. dollied and specimens. *e* Includes 1,624·76ozs. of alluvial and 320·06ozs. dollied and specimens. *f* Includes 1,259·65ozs. of alluvial and 1,739·76ozs. dollied and specimens. *g* Includes 665·55ozs. of alluvial and 550·61ozs. dollied and specimens. *h* Includes 759·33ozs. of alluvial and 1,743·61ozs. dollied and specimens.

BROAD ARROW GOLDFIELD.

The Broad Arrow field, declared by proclamation gazetted on the 17th November, 1896, to take effect from the 20th of that month, embraces an area of 590 square miles, and is defined by the authorities as being:—

Bounded by lines starting from Survey Station R3; thence east about 17 miles 30 chains to a point north of the most northerly corner of the East Coolgardie Goldfield; thence south about 29 miles 70 chains to that corner; thence about 234° 51′ 14¼ miles to the 40-Mile post on part of the eastern boundary of the Coolgardie Goldfield; thence about 324° 46′ 9 miles 32 chains 44 links; thence north 30 miles 47 chains 56 links to the starting point.

The geological features and mode of occurrence of the ore deposits of this field bear a strong similarity to those of Coolgardie.

The gold produced from this field has been derived from three sources, viz., alluvial deposits, lode formations, and quartz reefs. The gold from the alluvial deposits presents all the usual characters. The lodes, so far as observations have been carried, are usually banded, and practically distinguishable from the country rock only by their auriferous character. The quartz reefs, which invariably occur in intimate association with the acid eruptive dykes, are of two distinct varieties. The first occur as lenticular patches, from which small quartz veins emanate in all directions. These branching veins appear to be richer. The second type are those banded rocks which consist of alternating layers of crypto-crystalline quartz and hematite. The proportion of oxides of iron varies from a practically pure hematite to a quartz rock, through which such small quantities of hematite are disseminated as to give it a brown or bluish appearance. These banded rocks seem to have been permeated with secondary silica, which has also penetrated the surrounding rocks. Although these banded quartzites have proved auriferous, none of them have so far shown themselves to be payable; in the circumstances that these banded quartz rocks are a possible source of gold, they are identical with the quartzites of Peak Hill (to which reference has been made on an earlier page) and of Mount Margaret.

The principal mining centres of the field are Bardoc, Black Flag, Broad Arrow, and Paddington.

After several years of declining output, a considerable advance is shown by the record of the field for 1903; the yield of 29,969ozs. being an increase of 32 per cent. over that for the preceding year. The total output up to the end of 1903 amounted to 236,267ozs.

The following table shows the yield of the field up to the close of 1903:—

Yield of the Broad Arrow Goldfield.

Year.	Ore Crushed.	Yield of Gold therefrom.	Gold Exported and received at Perth Mint.	
			Gross Weight.	Fine Contents.
	tons.	ozs.	ozs.	ozs.
1896	*a* 1,536·20	*b* 9,129·25	...	...
1897	19,636·30	*c* 14,464·54	*j* 4,159·27	3,720·87
1898	32,004·06	*d* 27,726·43	24,631·44	22,035·17
1899	59,976·40	*e* 48,194·38	44,524·29	39,831·22
1900	73,493·17	*f* 52,433·32	47,860·59	42,815·87
1901	44,740·13	*g* 34,675·44	29,104·78	26,379·59
1902	23,684·85	*h* 19,675·20	18,380·47	15,794·01
1903	35,826·15	*i* 29,969·13	27,665·13	23,446·53
Total	**290,897·26**	**236,267·69**	**196,325·97**	**174,023·26**

a Complete details not available. *b* Complete details not available; includes 250ozs. from unknown tons. *c* Includes 27·20ozs. dollied and specimens. *d* Includes 1,483·59ozs. of alluvial and 270·42ozs. dollied and specimens. *e* 114·21ozs. of alluvial and 197·93ozs. dollied and specimens. *f* Includes 1,470·26ozs. of alluvial and 268·44ozs. dollied and specimens. *g* Includes 1,229·52ozs. of alluvial and 161·30ozs. dollied and specimens. *h* Includes 984·43ozs. of alluvial and 162·25ozs. dollied and specimens. *i* Includes 2,940·43ozs. of alluvial and 68·50ozs. dollied and specimens. *j* No detail available prior to 1st September, 1897.

EAST COOLGARDIE GOLDFIELD.

This comparatively small field, the most productive in Australia, embraces an area of 632 square miles. It was declared by proclamation gazetted on the 21st September, 1894, to take effect from the 1st October of that year; its boundaries were amended by proclamation gazetted on the 20th March, 1896, to take effect from the 15th April following. It is defined by the authorities as being:—

Bounded by lines starting from a mile-post on the eastern boundary of the Coolgardie Goldfield, 40 miles southerly from Survey Station R3 and extending 144 degrees 46 minutes 26 miles 62 chains 37 links along a surveyed line to the north-east corner of Location 53; thence southerly along the eastern boundary of Location 53 and the western boundary of Location 51 to the south-west corner of Location 51; thence along the boundaries of that location easterly 119 chains 87 links, northerly 60 chains, easterly 160 chains to a point on the western boundaries of Location 48, southerly 564 chains 87 links, easterly 443 chains 91 links to the south-east corner of that location; thence easterly about 7 miles 65 chains to a point south of the south-east corner of Location 45; thence north to the said corner; thence north along the eastern boundary of Location 45, 4 miles, to its north-east corner; thence about 342 degrees 10 minutes about 1 mile 64 chains to the south-east corner of Location 44; thence along the eastern boundary of Location 44 to its north-east corner; thence 321 degrees 35 minutes about 30 miles 53 chains to a point bearing about 54 degrees 50 minutes from the 40-mile post on the eastern boundary of the Coolgardie Goldfield; thence about 234 degrees 50 minutes about 14¼ miles to the starting point.

Kalgoorlie, the official centre of the East Coolgardie Goldfield, was in the first instance called Hannan's, after Patrick Hannan, the original discoverer of the field; the other principal mining centres are Boulder, Boorara, and Feysville.

The principal topographical feature of the field consists of a low broken Range, of which Mount Charlotte, 1,378 feet above sea-level, forms the highest summit, and which trends generally north-north-west from the head of Hannan's Lake. This line of comparatively low hills diminishes in altitude from Mount Charlotte to a mere ridge, which gradually merges into the flat ground surrounding the lake and forms the main water-parting of the district. To the eastward, the country extends in a wide, gently-sloping valley, with a southerly fall, flanked by a line of low hills some six or seven miles distant; to the westward again is another valley of about two miles in width.

By far the larger portion of the field is covered with a mantle of reddish loamy soil and other superficial accumulations of variable thickness. These superficial deposits consist of ironstone gravels and cement, passing in certain isolated localities into practically pure brown hematite. Some of the surface deposits have proved to be highly auriferous in places.

The rocks of the field consist of:—

(1.) Amphibolites and other derivatives, including most of the lode stuff.

(2.) New eruptives, both acid, intermediate, and ultra-basic.

(3.) Sedimentary rocks.

The amphibolites which form not only the country rocks of the productive ore-bodies of Kalgoorlie, but also, in a much altered form, the greater number of the "lode formations" themselves, possess the highest interest. Owing to the varying and sometimes extreme alteration that they have undergone, the rocks present an almost endless variety of form and (within certain limits) composition. They appear to resemble very closely the greenstone schists of the south shore of Lake Superior, North America, which are associated with important deposits of iron ore. The Kalgoorlie amphibolite rocks are of four main types, viz., massive and foliated amphibolites, massive and foliated greenstones (chlorite-rock), chlorite schist, and massive and foliated siderite-rock.

The minerals which have been recognised in these rocks are hornblende, plagioclase, orthoclase, quartz, limonite, and magnetite, all of which may be original constituents, or wholly or partially secondary, together with the undoubtedly secondary minerals chlorite, epidote, zoisite, sericite, leucoxene, rutile, calcite, dolomite, siderite, and pyrites, with occasionally lollingite, gold, etc.

All the amphibolites and other derivatives are portions of the one mass, and have originally been one and the same. No remnants of that original rock being left unaltered, its exact nature cannot be determined. That it was an igneous rock appears certain from the presence of limonite, hornblende, and areas of micropegmatite, and from the absence of fossils or water-worn inclusions. It may have been a diabase or plagioclase-augite rock. The original rock has been metamorphosed in three ways: By molecular rearrangement, with the production of secondary hornblende; mechanically, many of the minerals being fractured or crushed, and more or less foliation set up; chemically, by the absorption of water, carbonic acid, sulphur, etc., resulting in a complete destruction of original minerals and the formation of secondary chlorite, calcite, quartz, etc. The so-called "lode formations" are in most cases merely bands of this igneous rock which have been permeated by solutions of the precious metals.

Traversing the main mass of amphibolite and older sediments are several intrusive masses of felspar-porphyry, porphyrite, and peridotite.

Surrounded on all sides by the igneous rocks, and dipping at a high angle, are a series of sedimentary rocks, ranging on the one hand from a soft shale to a jasperoid slate, and on the other from a sandstone to a flinty quartzite. The effect of metamorphism on these rocks has been as varying in its intensity as on the amphibolites. Soft grey shales and ironstones pass into fine grey or graphitic slates, in which secondary silification has sometimes gone on up to the point of converting the rock into an opaque banded jasper. Graphite to the extent of 5 per cent. or more is a frequent constituent in the slates. It may owe its origin to the alteration of organic matter originally existent in the rocks, or to the subsequent intrusion of vapours of hydrocarbons into the beds. A peculiar feature of the graphitic slates are spherical nodules of pyrites from $\frac{1}{8}$ inch up to an inch or more in diameter, which are frequently enclosed in them.

Of siliceous sediments, soft sandstones are of rare occurrence, but narrow bands of sandy material do occur with the shales. Flinty quartzite is of frequent occurrence, ranging in composition from almost pure silica to various mixtures of quartz, clay, and iron oxides, the latter, however, being seldom found in notable quantities.

Breccias occur in several parts of the field.

The newer sediments are of two kinds, chemical and mechanical. The former includes salt, travertine, siliceous sinter, and laterite; the latter, sand, clay, and ironstone gravel.

The lodes of Kalgoorlie consist of a series of almost vertical banded schistose formations (merely country rock more or less altered by dynamic changes) which have a general trend of from north 30° west to north 50° west. These deposits are lenticular in habit, the lenses being often of great length. Instances occur which go to prove that some of these may reach over half a mile in length. At times, however, the lateral continuity of the lenses is interrupted by faults of very variablé downthrow. As a general rule the ore deposits have no well-defined walls, but seem to pass insensibly into the surrounding rock. The lodes are often traversed by a network of quartz veins, which ramify in all directions. There is abundant evidence attesting the fact that the rocks have been subjected to profound dynamic phenomena, which has resulted in the production of lines of weakness along which mineral-bearing solutions have found a comparatively easy passage. The width of the ore bodies reaches as much as 80 feet in places. The gold occurs free, as tellurides, and as auriferous pyrrhotite. The free gold presents such characters as point to its having been derived from the oxidation of the tellurium-bearing minerals; the decomposition of the auriferous pyrites may also be the source of some portion of it. The free gold often occurs in spongy or cellular masses of varying sizes and shapes, and is at times coated with a dull clayey ferruginous material of a yellow colour, known as "mustard gold," which may represent an oxidised form of tellurium. The tellurides of gold occur chiefly as Calaverite.

The yield of the field for 1903 amounted to 1,275,628ozs., an increase of 14 per cent. on that of the previous year, and more than half of the total yield of the State; the average yield per ton of ore milled was 1·32ozs. The total gold reported to the Mines Department up to the end of 1903 amounts to 5,846,949ozs.

Outside prospecting is still being carried on, particularly at the north end of the field in the neighbourhood of Boorara.

The following table shows the yield of the East Coolgardie Goldfield up to the close of 1903:—

Yield of the East Coolgardie Goldfield.

Year.	Ore Crushed.	Yield of Gold therefrom.	Gold Exported and received at Perth Mint.	
			Gross Weight.	Fine Contents.
	tons.	ozs.	ozs.	ozs.
1896	47,026·34	*a* 143,828·70	*i* 85,287·06	76,297·42
1897	117,565·72	*b* 296,764·11	300,037·24	268,411·95
1898	264,324·76	*c* 422,391·86	450,312·27	402,847·31
1899	466,868·09	*d* 860,371·72	923,617·70	826,264·21
1900	491,720·00	*e* 737,970·98	810,906·78	725,433·53
1901	693,828·73	*f* 991,378·20	1,033,669·64	936,883·49
1902	842,185·61	*g* 1,118,615·71	1,172,404·84	1,007,426·94
1903	966,793·51	*h* 1,275,627·82	1,358,374·81	1,151,238·24
Total	**3,890,313·76**	**5,846,949·10**	**6,134,610·34**	**5,394,803·09**

a Includes 500ozs. from unknown tons. *b* Includes 46·15ozs. of dollied and specimens. *c* Includes 148ozs. of dollied and specimens. *d* Includes 5,503·70ozs. of alluvial and 29·56ozs. dollied and specimens. *e* Includes 2,295·56ozs. of alluvial and 2,019·24ozs. dollied and specimens. *f* Includes 1,331ozs. of alluvial and 1,247·85ozs. dollied and specimens. *g* Includes 3,063·89ozs. of alluvial and 6,807·18ozs. dollied and specimens. *h* Includes 752·94ozs. of alluvial and 1,013·45ozs. dollied and specimens. *i* Included with Coolgardie prior to 1st May, 1896.

NORTH-EAST COOLGARDIE GOLDFIELD.

This Goldfield was declared by proclamation gazetted on the 20th March, 1896, to take effect from the 15th April of that year; its boundaries were amended during the same year by proclamation gazetted on the 13th November, to take effect from the 20th of the same month. It embraces an area of 21,542 square miles, and, according to the authorities, it is comprised by—

Lines starting from a point situate about 17 miles 30 chains east of Survey Station R3; thence south about 29 miles 70 chains to the most northerly corner of the East Coolgardie Goldfield; thence about 141 degrees 35 minutes about 30 miles 53 chains to the north-east corner of location 44; thence along the eastern boundary of that location to its south-east corner; thence about 162 degrees 10 minutes about 1 mile 64 chains to the north-east corner of Location 45; thence along the eastern boundary of that location to its south-east corner; thence south to a point 7 miles 65 chains east from the south-east corner of Location 48; thence east about 27 miles 15 chains; thence south about 48 miles to the south-east corner of the Coolgardie Goldfield; thence east to the 125th meridian of east longitude; thence north along that meridian to a point east of Survey Station R3 aforesaid; thence west to the starting point.

For administrative purposes the field is divided into three districts: — Kanowna (White Feather), Bulong (I.O.U.), and Kurnalpi.

Kanowna. — The fundamental rocks of the Kanowna district are chlorite, talcose, and serpentinous schists, invaded by dykes of acid eruptive rocks, which have a prevailing north-easterly strike and an easterly dip. The schists, so far as has been disclosed by mining operations, are all in an advanced stage of decomposition. They have proved to be highly auriferous in places. The granitic rocks which contain gold in appreciable quantity are reticulated by interlacing quartz veins, which are also auriferous; these appear to have been prospected with considerable success.

Considerable interest, however, at Kanowna attaches to the alluvial leads, which have been extensively worked. The most prominent of these is the North Lead, which lies in a natural depression which has been traced from the Cemetry to G.M.L. 918. The North Lead lies in an old watercourse carved out of the older rocks, and has been proved to be not merely a simple isolated run of auriferous gravel, but part of a series of old stream deposits, which took their rise in the comparatively elevated ground to the east and flowed in a general westerly direction.

The lead trends generally northwards as far as the G.M.L. 923, when its course is suddenly deflected to the east. It is joined near the Birthday Gift Claim by what is known as Wilson's Gully Lead, which enters from the south. Some distance below the junction the North Lead loses itself in an extensive flat, which may prove to be merely a lake-like expansion of its channel. The connection of the Q.E.D. Lead on the north, although it trends in such a direction as to fall into the North Lead, has not yet been definitely proved. All things point to such a connection, though it may be that the lead has been lost by denudation.

The width of the old stream varies from two to 80 feet, having an average, according to departmental observations, of about 15 feet. The thickness of the deposit in the old channel varies from a few inches up to as much as 90 feet. The fall of the lead is about at the rate of 40 feet to the mile.

The deposits filling the old watercourse naturally vary somewhat in different portions. They consist first of a variable thickness of surface loams, etc., succeeded by ironstone gravels partially cemented in places by kaolin and oxide of iron into solid rock. Beneath this lies a bed or beds of practically pure kaolin ("pug"), and a varying thickness of a pebbly quartz wash. The wash contains rounded and subangular pebbles of quartz, which, in the upper portion of the deposit, is often associated with kaolin and sand. This quartz wash is cemented by secondary silica into a hard, compact rock, which, in hand specimens, might easily be mistaken for quartzite.

So far as mining operations have, up to the present, been carried out, it would seem that the whole of the detrital deposits have not proved auriferous. Most of the alluvial gold has been won from the pebbly quartz wash, although the overlying kaolin ("pug") and ironstone gravel have also yielded a certain quantity.

The ultimate derivation of the gold in the North Lead is from the quartz veins and lodes (upon which the wash directly reposes in places) by which the crystalline rocks are traversed; for the gold is not exclusively in the form of grains, scales, etc., but is found occurring in the quartz pebbles themselves.

In addition to what may be called detrital gold, there is another massive, arborescent, or coarsely crystalline form which occurs, filling certain irregular cracks, and covering cleavage planes or shrinkage cracks so as to present the appearance of painted surfaces.

The mode of occurrence, associations, and character of this gold all point to a secondary origin; and it is of importance to note that this, what may be called secondary gold, has been deposited from solution, not only in the alluvium and other superficial deposits, but also in the zone of decomposition of the bed-rock. These secondary forms, which result in the superficial enrichment of many auriferous deposits, are a common feature in the mineral fields of the State.

Of the age of the North Lead there is no evidence available at the present time.. The fact that at a date subsequent to its formation a sufficient length of time has elapsed to allow of the lead being sealed up by great accumulations of superficial deposits (some of which have been consolidated into solid rock) may point to considerable geological antiquity.

There are no data available by which the average fineness of the gold from the North Lead can be obtained.

That many other similar leads probably exist is obvious from the geological structure of the district, though, owing to the completeness by which they have been sealed up by the more recent accumulations, they can only be tapped by a judicious system of prospecting.

It is impossible to arrive at the gold yield of the portion of Kanowna traversed by the old watercourse, owing to there being no separate returns furnished by the claimholders on the North Lead. The returns, which are appended, show that up to the end of 1903 the lodes from Kanowna yielded 218,814·30ozs. of gold by crushing 251,640·20 tons of ore. The alluvial deposits, the gravels, yielded 113,574·92ozs. of gold, and 112,786·42 tons of cement crushed were responsible for 116,535·81ozs. From these data it will be seen that the alluvial deposits turned out 51 per cent. of the total production.

Gold Production of Kanowna.

Year.	Ore Crushed.	Yield of Gold therefrom.	Rate per ton.
I.—LODES.	tons.	ozs.	ozs.
Previous to 1898	27,365·55	28,243·77	1·03
1898	24,838·10	20,892·00	·83
1899	20,735·50	19,680·02	·94
1900	43,573·05	29,674·01	·68
1901	38,073·75	33,915·42	·89
1902	40,192·10	42,181·67	1·04
1903	56,862·15	44,227·41	·77
Total	**251,640·20**	**218,814·30**	**·87**
II.—ALLUVIAL DEPOSITS.			
(*a.*)—*Gravel.*			
Previous to 1898	....	10,611·92	...
1898	...	63,548·02	...
1899	...	19,462·29	...
1900	...	8,931·83	...
1901	...	5,778·41	...
1902	...	3,410·02	...
1903	...	1,832·43	...
Total	...	**113,574·92**	...
(*b.*)—*Cement.*			
Previous to 1898	*	*	...
1898	45,983·22	68,183·54	1·48
1899	41,429·95	35,494·31	·85
1900	15,870·00	8,776·82	·55
1901	2,485·75	1,176·44	·47
1902	3,464·50	1,373·58	·39
1903	3,553·00	1,531·12	·43
Total	**112,786·42**	**116,535·81**	**1·03**

* No data.

Bulong.—The Bulong, or I.O.U., Mining District never has been the subject of geological examination, so that the information is far from complete. The country rock is described by Mr. S. Göczel, a former member of the staff, as being partly diorite and partly diabase, both having been much subject to decomposition. A large North and South reef is said to form an important feature; two miles to the West of this is a stretch of country, about two miles long, in which several gold-bearing lodes occur.

On the ground held by the Mystery Gold-Mining Company, large quantities of gold have been obtained from the superficial covering of a ferruginous deposit (laterite) which covers such extensive areas in the State. The deposit is described as a gritty limonite, interbedded with clayey ironstone.

The alluvial deposits of Bulong, some of which have been worked at a depth of over 100 feet, yielded, up to the close of 1903, 26,517·53ozs. of gold. Several leads have been worked, but as they have never been geologically mapped, details in connection with them are wanting.

Kurnalpi.—Of the Kurnalpi District very little information is available, but prospecting work is continuing. At Mulgabbie, an outlaying centre about 35 miles to the north, some telluride minerals, chiefly petzite, were recently discovered in one of the deposits; sufficient development, however, has not yet been accomplished to thoroughly determine the value of the find.

The output of the North-East Coolgardie, which has produced so much ore in the past, was, during 1903, 62,920ozs. and, as compared with 1902, showed a decrease of four per cent. This is largely accounted for by a decrease in the output from the leads of Kanowna. The total gold reported to the Mines Department up to the end of 1903 amounted to 597,122ozs.

The following table shows the yield of gold up to the close of 1903:—

Yield of the North-East Coolgardie Goldfield.

Year.	Ore Crushed.	Yield of Gold therefrom.	Gold Exported and received at Perth Mint.	
			Gross Weight.	Fine Contents.
	tons.	ozs.	ozs.	ozs.
1896	5,682·30	[a]8,975·95	[i]4,113·18	3,679·63
1897	28,546·25	[b]40,453·10	32,905·82	29,437·40
1898	80,095·83	[c]170,441·73	125,240·49	112,039·58
1899	82,716·30	[d]112,825·45	81,171·18	72,615·37
1900	70,713·05	[e]70,745·86	52,129·12	46,634·47
1901	51,978·25	[f]63,651·70	50,556·53	45,822·74
1902	57,181·10	[g]67,108·60	54,540·57	46,865·74
1903	70,949·05	[h]62,919·74	47,733·54	40,454·74
Total	**447,862·13**	**597,122·13**	**448,390·43**	**397,549·67**

[a] Includes 150ozs. dollied and specimens. [b] Includes 10,917·95ozs. of alluvial and 886·23ozs. dollied and specimens. [c] Includes 69,069·76ozs. of alluvial and 1,115·57ozs. dollied and specimens. [d] Includes 34,527·80ozs. of alluvial and 1,648·87ozs. dollied and specimens. [e] Includes 16,099·57ozs. of alluvial and 4,623·54ozs. dollied and specimens. [f] Includes 10,498·93ozs. of alluvial and 3,595·71ozs. dollied and specimens. [g] Includes 5,923·09ozs. of alluvial and 2,291·23ozs. dollied and specimens. [h] Includes 4,323·54ozs. of alluvial and 2,100·90ozs. dollied and specimens. [i] Prior to 1st May, 1896, included with Coolgardie.

DUNDAS GOLDFIELD.

This field, the most southerly of the Eastern fields, was proclaimed on the 31st August, 1893, its boundaries being subsequently amended by proclamation gazetted on the 22nd August, 1902, to take effect from the 1st September of that year. It embraces an area of 11,500 square miles, which, according to the authorites, is defined as—

> Commencing at the south-east corner of the Coolgardie Goldfield; thence east about 42½ miles; thence south about 66 miles; thence west about 173 miles, passing through the 75-mile post on the Dundas-Esperance Road; thence north about 66 miles to the south-west corner of the said Coolgardie Goldfield; thence east about 132½ miles along its southern boundary to the starting point.

Although the area proclaimed as a goldfield is of considerable extent, the actual portion over which gold has been discovered is small, and seems to be confined to the Dundas Range and its northern extension; or, in other words, the belt of land that lies between Lake Cowan and Lake Dundas.

Gold was first discovered in the year 1892, at the southern end of the Dundas Range; but as the reefs did not prove to be very rich, little mining is being carried on at that locality at the present time.

It seems that Mr. Moir, of Fanny's Cove, was the first to detect gold in the country now embraced by this field. The discovery was made in the alluvium of one of the creeks when this gentleman was engaged in searching for pastoral lands. No effort would appear to have been made to give further attention to the district until some years later, when Mr. Moir organised a prospecting party, which, however, was not successful. About the same time further prospecting was carried out by other parties, which resulted in the discovery of a rich reef called the "May Bell" and another called the "Scotia."

The rocks of the gold-bearing belt are similar to those of the Coolgardie District, and, like that locality, the richest lodes are situated in the contact zone, upon the eastern side of the granite. The belt is dislocated and considerably disturbed in places by the intrusion of large diorite dykes, which rise as rough, reddish black hills here and there, running in an almost east and west direction.

The principal mining centres of the field are Dundas, Norseman, and Peninsula.

There are about three distinct main lines of auriferous lodes, most of which dip at an angle of about 45 degrees, and vary considerably in size and richness.

The output of the field for 1903 was 40,173·60ozs., which, as compared with that for 1902, 34,750·60ozs., shows an increase of 16 per cent., and the average yield per ton of ore treated was 1·55ozs.; the increase is, therefore, due rather to a higher grade of ore than to a larger output.

The following table shows the gold yield of Dundas up to the close of 1903:—

Yield of the Dundas Goldfield.

Year.	Ore Crushed.	Yield of Gold therefrom.	Gold Exported and received at Perth Mint.	
			Gross Weight.	Fine Contents.
	tons.	ozs.	ozs.	ozs.
1893	*a*2,923·00	*a*3,979·90	*i*147·97	132·77
1894			228·38	204·31
1895			241·90	216·40
1896			4,350·31	3,891·77
1897	16,979·98	*b*19,283·52	19,310·81	17,275·36
1898	30,928·35	*c*36,798·48	32,031·82	28,655·52
1899	59,379·30	*d*44,213·30	45,164·95	40,404·36
1900	49,014·50	*e*41,083·63	40,687·56	36,396·91
1901	38,373·00	*f*37,084·09	38,796·25	35,163·62
1902	26,123·75	*g*34,750·60	36,210·99	31,115·47
1903	25,953·00	*h*40,173·60	41,553·90	35,217·41
Total	**249,674·88**	**257,367·12**	**258,724·84**	**228,675·50**

a. Details not available. *b*. Includes 77·50ozs. dollied and specimens. *c*. Includes 5·60ozs. dollied and specimens. *d*. Includes 142·75ozs. of alluvial and 146·18ozs. dollied and specimens. *e*. Includes 166·13ozs. of alluvial and 35·48ozs. dollied and specimens. *f*. Includes 623·82ozs. of alluvial and 180·05ozs. dollied and specimens. *g*. Includes 435·32ozs. of alluvial and 1,110·43ozs. dollied and specimens. *h*. Includes 503·74ozs. of alluvial and 793·94ozs. dollied and specimens. *i*. Prior to 1893 included with Yilgarn.

DONNYBROOK GOLDFIELD.

This little goldfield is situated between Geographe Bay and the Greenbushes Tinfield. It was declared by proclamation gazetted on the 17th November, 1899, to take effect from the 27th of that month, and comprises an area of 102 square miles. The authorities define its boundaries as follows:—

Starting from the south-western corner of Reserve 6321 (Covenley Townsite); thence north about 60 chains to the Boyanup-Bridgetown Railway Reserve; thence by the western boundary of said Railway Reserve in a general north-westerly direction about 1¼ miles to its intersection with the eastern boundary of Wellington Location 239; thence north about 10 chains to the left bank of the Preston River; thence by said river in a general north-easterly direction about two and a-quarter miles to the north-eastern corner of Reserve 645A; thence north about three miles; thence west about seven miles to the eastern boundary of Boyanup-Bridgetown Railway Reserve; thence by said Railway Reserve in a general south-easterly direction about three and three-quarter miles to a point north of north-west corner of Wellington Location 836; thence south about 13¼ miles; thence east about nine and a quarter miles to the point of commencement.

Donnybrook is situated on the Bunbury and Bridgetown Railway, and is 26 miles south-east of Bunbury and 131 miles by rail from Perth. The scene of mining operations is some two miles to the south of the Donnybrook Townsite, on a small branch of the Preston River, in the Blackwood Range. Gold would seem to have been first discovered in 1897, by a party of prospectors searching for alluvial gold. Further investigations carried on eventually led to the discovery of auriferous quartz veins, from which most of the gold had originally been shed.

The country rocks of the field consist of massive hornblende and gneissic granites, intersected by a belt of hornblende rock trending north and south, and traceable for some considerable distance in a southerly direction. The width of the belt of dioritic rock varies from a quarter of a mile, though it has never been found to exceed a mile. In hand specimens the rock is found to consist of coarse hornblende crystals, associated with more or less decomposed felspars. The western edge of the dyke has a banded structure, and resembles hornblende schist; in isolated cases it is found occurring as an exceedingly fine-grained and exceptionally hard rock. The granite naturally varies considerably in texture and composition, though, as a whole, it is a hornblende granite. In several localities the hornblende is almost entirely replaced by muscovite mica. Epidote is found occurring as a rock-forming mineral in the granite. Recent developments have shown the existence of extensive deposits of sandstone lying beneath the ubiquitous ironstone gravels. These sandstones, which are usually of a light grey colour, are fine-grained and of an even texture. The maximum thickness attained by the sandstone is not less than 150 feet.

The quartz reefs all occur in the granite to the west of the diorite, always in close proximity to the junction of the two rocks. The general strike of the reefs is a little to the west of north and east of south, with a high dip to the east. Mining operations have shown that payable quartz reefs occur in the sandstone as well as in the unaltered granite.

Some of the gold from Donnybrook occurs in the filmy arborescent form, which points to a secondary origin.

The output of the field for 1903 amounted only to 58ozs., and mining is practically at a standstill; a little prospecting with diamond drills is being done on one property.

The following table shows the yield of the field since 1898:—

Yield of the Donnybrook Goldfield.

Year.	Ore crushed.	Yield of Gold therefrom.	Gold Exported and received at Perth Mint.	
			Gross Weight.	Fine Contents.
	tons.	ozs.	ozs.	ozs.
1898	18·00	14·65	*b*	*b*
1899	294·80	*a* 511·49	506·11	452·76
1900	360·00	453·10	265·55	237·56
1901	48·50	3·86	4·64	4·20
1902	532·00	100·73	72·83	62·58
1903	400·00	58·05	97·52	82·64
Total	**1,653·30**	**1,141·88**	**946·65**	**839·74**

a Includes 32·10ozs. of alluvial. *b* No details available prior to 1st March, 1898.

PHILLIPS RIVER GOLDFIELD.

The discovery of gold-bearing reefs in the Phillips River Mining District led to its being declared a goldfield in September, 1900, the proclamation being gazetted on the 21st, to take effect from the 14th of that month. The boundaries were amended by proclamation gazetted on the 22nd of August, 1902, to take effect from the 1st of September of that year, according to which it embraces an area of 3,850 square miles, circumscribed as follows:—

> Starting from a point on the Southern coast, distant about two miles northerly from Red Island; thence north about 80 miles, passing through the summit of Mt. Madden; thence east about 73 miles, along part of the Southern boundary of the Dundas Goldfield to a spot 10 miles easterly from Peak Charles; thence south 33 miles; thence west 40 miles; thence south about 43 miles to the coast; thence westerly along the said coast to the point of commencement.

The field is accessible from the port of Hopetoun, on Mary Ann Harbour, on the south coast.

A few miles to the westward of Hopetoun a bold rock mass rises abruptly, called "East Mount Barren;" this is the eastern end of a range which runs along the coast for a distance of about 40 miles, the rocks of which, consisting of hard, highly crystalline rocks and quartzites, are destitute of metalliferous mineral veins.

From the eastern end of this range is a low semicircular range of schistose rocks, with large pink quartz reefs, traversed by numerous porphyritic dykes, having a well-defined north-west and south-east course, whilst diorite dykes are of less frequent occurrence. These rocks, to judge from their weathered surface, are horneblende and mica-schists, with veins of dolomitic limestone, the latter having probably furnished the magnesian limestone with which the fragments of the rocks are encrusted. This series, so far, has not proved to be metalliferous. In the Phillips River basin a marked change in the nature of the country is at once apparent, and the geological features are in many ways similar to those of the Southern Cross, Coolgardie, and Norseman fields. The rocks prove to be hornblendic and mica-schists, similar to those of the Northern Goldfields, with granite and feldspathic dykes, the latter of which are often garnetiferous, whilst diorite dykes are abundant, and are of considerable extent and size, having apparently exercised a direct influence upon the formation of the mineral veins which occur in this series.

Of the dykes, the granite (locally called "mica bars") are the most recent, for they often cut through the lodes, whilst probably the diorite are next.

The Ravensthorpe Range consists more of the granitic series, being capped by ferruginous sandstones, and is untraversed by diorite dykes or mineral veins; the only dislocation being at the gap where it takes its turn south-east at the apex of the diorite intrusion.

Here, as elsewhere on the southern coast, the metalliferous series has been thrown into a more or less easterly and westerly direction by a great granite intrusion.

The mines are on the western fall from the Ravensthorpe Range, at the head of the drainage areas of the Steere and Phillips Rivers, and the township of Ravensthorpe, the centre of the field, is about 30 miles, by road, inland from Hopetoun.

The lodes may be divided into two classes—those in which copper is of the greater intrinsic value and those in which gold is. The first of these have been opened upon at three different parts of the field, viz., Ravensthorpe, Mt. Desmond, and Harbour View.

The Ravensthorpe belt of copper lodes strikes in an east-north-east and west-south-westerly direction from the north-west corner of the township, and extends for a distance of five miles; it consists of two groups. The first, or central, lies to the north of the township, and extends continuously for a distance of two miles, after which there is a gap of one and a-half miles, and then the eastern group of leases for a distance of one and a-half miles.

Three miles in a west-south-westerly direction from the westernmost lease of the central group are three large mineral leases, which may be called the western group, upon which the earliest discoveries of mineral upon this field were made; these are possibly upon the same belt, but no definite statement can be made since lines of rock outcrop cannot be traced, owing to the thickness of the superficial deposits; prospecting is therefore rendered difficult, and the presence of reefs and lodes only determined by small fragments upon the surface. This, it may be remarked, is the general characteristic in the Ravensthorpe District of both gold and copper lodes; whilst further it is not at all exceptional to discover, after finding fragments of lode matter upon the surface, that some four to six feet of clay, destitute of stone, has to be passed through before the cap of the lode is encountered.

Although this belt has a general direction east-north-east and west-south-west, the individual lodes, as a rule, strike almost east and west, or a few degrees north of east and south of west, with a general northerly dip; the exception being in some few lodes which dip to the southward.

The following table shows the yield of the Phillips River Goldfield:—

Yield of the Phillips River Goldfield.

Year.	Ore crushed.	Yield of Gold therefrom.	Yield of Gold from smelting Copper Ores.	Total Gold Yield.	Gold Exported and received at Perth Mint.	
					Gross Weight.	Fine Contents.
	tons.	ozs.	ozs.	ozs.	ozs.	ozs.
1900 ...	...	...	39·00	39·00	[c]	[c]
1901 ...	192·00	225·73	487·11	712·84	[c]	[c]
1902 ...	9,390·25	[a]8,494·36	...	8,494·36	8,575·86	7,369·09
1903 ...	8,179·75	[b]7,688·83	·54	7,689·37	8,941·21	7,577·77
Total	17,762·00	16,408·92	526·65	16,935·57	17,517·07	14,946·86

[a] Includes 44ozs. of alluvial and 5ozs. dollied and specimens. [b] Includes 227ozs. of alluvial and 37·67ozs. dollied and specimens. [c] Details not available.

COPPER.

Copper mining in Western Australia cannot be said to have made continuous progress, and only a proportion of the output of the mines is reduced to metal in the State. The annual production has shown much variation.

The ores, however, are plentifully distributed throughout the State, particularly in the North-West, but so far, on account chiefly of their not generally carrying any gold, have only been worked in a few localities, notably:—Tambourah, Pilbara District; Whim Creek, Egina, Hong Kong, Croydon, Roebourne, all in the West Pilbara District; Red Hill and Uaroo, in the North-West District; Day Dawn, Murchison District; Geraldine, Northampton, Yandanooka, and Arrino, all in the South-West District; Murrin Murrin, Mount Margaret District; Mulline, North Coolgardie District; Arrow Lake, Broad Arrow District; Boorara, East Coolgardie District; Ravensthorpe, Harbour View, Phillips River District.

Very little has been done in the examination of the copper deposits of the State, but so far they seem to be of two kinds, viz.:—

(1.) True lodes.

(2.) Impregnations and stockworks.

The majority of the workable deposits apparently belong to the former class.

The principal sources of copper ore have been the districts of West Pilbara, Mount Malcolm, Phillips River, Day Dawn, and Northampton; the largest output being that of the West Pilbara District, derived in great part from the locality of Whim Creek.

The yield of the deposits at Murrin Murrin, in the Mount Malcolm district, is next in importance, and a considerable proportion has also been derived from Ravensthorpe in the Phillips River Goldfield, which it appears likely will rise to greater prominence as a copper producing district.

The Phillips River Goldfield has already been referred to in connection with the gold output, and there is a very good record of production both of gold and copper from mines which are only in the first stage of development. The field is a promising one, and efforts are being made by the State to improve the condition of mining where there are a large number of mines not yet sufficiently developed to warrant the large expenditure necessary to put them on the most economical producing basis.

Arrangements have been made by the Government to purchase ores on assay value with a view to erecting a State Smelter, which it is believed, if the field be vigorously developed, will soon be required.

During the latter half of 1903, 3,386 tons of ore had been purchased, of an average value of 15 per cent. copper. The field suffers from want of a reduction works, the ores having hitherto had to be shipped to smelters in the Eastern States; this, combined with want of railway communication as well as the situation of the field, has rendered the cost of ore realization very high, and it is estimated that no ore that will realize an assay value of less than £8 or £8 10s. per ton will pay for taking out of the mines under present conditions.

The ores found on the field may be divided into—

(1.) Those fit for smelting at once.

(2.) Those requiring milling;

and for complete metallurgical treatment of the product of the different mines would be required smelting, crushing, amalgamating, concentrating, and cyanide processes.

The Yandanooka Mineral District is the most important example of the impregnations and stockworks, where there are several beds of mica schist and porous sandstone carrying malachite, with occasionally a little azurite or cuprite.

The sandstones carry ores of copper in close proximity to the junction of a mass of granite apparently intrusive, but the geological age and relation of the sedimentary and crystalline rocks has not been definitely fixed.

The deposits are in great part impregnations of green and blue carbonates in the form practically of stockworks along certain fissure joints by which the rock is traversed.

The ores average 10 to 12 per cent., are highly silicious, and are not apparently readily concentrated.

The State's total production of copper and copper ore amounts in value to £269,412, and the production for the year 1903 to £56,541, an increase of £48,451 over that of the previous year, chiefly from the Mt. Malcolm and Phillips River districts. The output from Mt. Malcolm is probably a somewhat inflated yield, but that from Phillips River is due to the State purchase of the ores.

The following tables give a summary of the production of copper ore in the State, and of the exports of ore, matte, and ingots, also the value of the more important imports for the last five years:—

Summary of Copper Ore raised, as reported to the Mines Department.

Year.	Day Dawn.	Mt. Malcolm.	Northampton.	Phillips River.	West Pilbara.	Total.	
						Quantity.	Value.
	tons.	tons.	tons.	tons.	tons.	tons.	£
Previous to 1899	...	...	...	...	7,018·00	7,018·00	55,270
1899 ...	...	273·00	136·00	...	2,555·00	2,964·00	35,938
1900 ...	5·15	4,539·00	...	34·00	1,605·00	6,183·15	43,673
1901 ...	10·50	7,660·00	38·50	1,089·14	1,162·00	9,960·14	69,900
1902 ...	...	1,954·00	...	308·25	...	2,262·25	8,090
1903 ...	...	18,965·00	...	1,561·33	...	20,526·33	56,541
Total ...	15·65	33,391·00	174·50	2,992·72	12,340·00	48,913·87	269,412

Quantity and Value of Copper Exports.

Year.	Ore.		Matte.		Ingot.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Previous to 1899	10,641·25	166,855·60	...	...	...	...	10,641·25	166,855·60
1899 ...	1,991·05	41,451·75	...	...	...	...	1,991·05	41,451·75
1900 ...	846·11	16,462·00	...	...	248·90	17,475·00	1,095·01	33,937·00
1901 ...	2,660·25	54,903·00	441·10	24,804·00	439·40	31,063·00	3,540·75	110,769·00
1902 ...	283·50	4,986·00	...	...	175·00	7,918·00	458·50	12,904·00
1903 ...	345·80	4,527·00	1,023·80	29,917·00	51·45	3,371·00	1,421·05	37,815·00
Total	16,767·96	289,185·35	1,464·90	54,721·00	914·75	59,826·00	19,147·61	403,732·35

Value of Copper Imports (1899 to 1903).

Year.	Ingot.	Rod, sheet, wire, and tube.	Manufactures, etc.*	Total.
	£	£	£	£
1899	561	3,103	556	4,220
1900	360	4,691	1,430	6,481
1901	1,134	4,939	2,066	8,139
1902	†	†	†	‡ 9,640
1903	†	†	†	7,052
Total Value				£35,532

* Includes coin. † Not separately classified by the Customs. ‡ Coin included with silver coin.

TIN.

The development of the tin deposits of the State has been considerably retarded by conditions tending against operations on a large scale; such disadvantages, however, are in some localities being gradually overcome, and the year's production of 817·05 tons shows an increase of nearly 32 per cent. over that of 1902.

Tin was first discovered in the latter part of 1888, and has since then been found occurring in several widely separated localities in the State, viz., at the heads of the Bow and the Lennard Rivers, in the Kimberley District; on the Thomas River, Gascoyne Goldfield; at Brockman's Soak and the Western Shaw, in the Pilbara District; and at Greenbushes, in the south-western portion of the State.

Pure tin oxide contains 78 per cent. of the metal, but the native compound invariably contains more or less of the oxides of other metals, with the result that it seldom assays over 74 per cent. of the metal. The Pilbara cassiterite, which is dark brown in colour, would appear to average 70 per cent.; that from Greenbushes, which is quite black, slightly less.

The tin deposits of the State, wherever examined, fall naturally into two distinct categories:—

Superficial deposits:
- (*a.*) Alluvial deposits.
- (*b.*) Residuary sands, gravels, etc.

Deposits in Country Rock:
- (*c.*) Tin-bearing granite and allied rocks.
- (*d.*) Tin-bearing dykes.

Alluvial Deposits.—These are the most important and vary very largely in nature, ranging from an extremely hard ferruginous conglomerate, to a stiff clay or loose sand or gravel. The tin stone in the first-named is often extremely coarse, but more generally one-tenth of an inch or less in diameter, whilst that in the softer material is almost uniformly fine. Assays of ten samples of this class of ore varied from ·9 per cent. up to 33·3 per cent. of the metal, the average being 10·1 per cent. The associated minerals are quartz, kaolin, limonite, ilmenite, tourmaline, tantalite, stibiotantalite, garnet, zircon, gold, magnetite, rutile, and topaz. No wolfram or scheelite has been detected in the ore: the mineral, once thought to be the latter, having proved in every case to be stibiotantalite. This mineral (a tantalite of antimony) and tantalite are of the greatest interest to the miners and smelters, since it is impossible to separate them from the tin stone by dressing, their specific gravities being practically identical. They have therefore to be smelted with the tin ore, and by contaminating the smelted tin with antimony, etc., seriously affect the purity and value of it. Owing principally to the presence of these two minerals the dressed ore from the alluvial claims has been found to be very variable in richness, ranging from a trace only of tin up to 72 per cent.

Residuary Deposits.—These are either lateritic ironstones or sands, clays, etc., derived from the decomposition *in situ* of igneous rocks. They are frequently stanniferous. The chief minerals accompanying the tin are limonite, quartz, tourmaline, clay, and mica.

Tin-bearing Granite and allied Rocks.—The tin-bearing granite consists of a granite passing in places into a foliated and highly-micacecous granite, with little or no felspar. This granite (greisen) contains tin, tourmaline, zircon, garnet, etc., as accessory constituents. In some parts of the field the tourmaline occurs in such quantity in the gneiss as to give a distinctive character to the rock, and would be better described as a tourmaline gneiss.

Tin-bearing Dykes.—These occur in several parts of the Greenbushes Tinfield.

The two districts from which an output of tin has been reported are Greenbushes and Marble Bar (Pilbara).

GREENBUSHES.

One of the most typical of the tin-bearing dykes occurs on the eastern side of the main road going south to Bridgetown, upon what was originally M.L. 82/76. A shaft has been put down to a shallow depth upon a tourmaline-bearing dyke, which was met with beneath the conglomerate at a depth of about five feet below the surface. The conglomerate contains detrital tourmaline, which led to the discovery of the dyke. As exposed in the workings, the width of the dyke is about two feet six inches, having a general north-westerly strike, with an underlie to the south-west at an angle of 70 degrees. The tourmaline is enclosed in a ferruginous clayey matrix, which contains occasional patches of quartzose material; the dyke may be a tourmaline-bearing pegmatite. The rock contains a small quantity of very angular tin, associated with large quantities of titanium. The tourmaline itself carries in parts appreciable quantities of tin. An assay of a carefully selected sample, believed to be characteristic of the whole dyke, yielded in the official laboratory 1·97 parts per hundred of metallic tin. There are several other parallel dykes throughout the field, but, so far, they have not been very much exploited, and do not appear to be very rich.

The following table shows the annual production of tin from the Greenbushes district as reported to the Mines Department prior to and since 1899:—

Production of Tin Ore from the Greenbushes District.

Year.	Quantity.	Value.
	tons.	£
Previous to 1899	1,590·33	66,108
1899	277·32	21,658
1900	435·62	29,528
1901	321·34	18,852
1902	403·21	24,680
1903	524·94	34,362
Total	**3.552·76**	**195.188**

MARBLE BAR.

(Pilbara.)

More than half the tin production of the Pilbara district, of which Marble Bar is the official centre, is obtained from Moolyella, the output of this locality at the end of 1903 being 855 tons, of an estimated value of £56,163.

The principal productive area of the Moolyella Tinfield, which embraces about nine square miles, is situated on the relatively high tableland drained by the head waters of Brockman's Creek and Talga River. The whole area is formed of an intrusive granite, the age of which has not yet been satisfactorily fixed.

The upheaval of the mass, and the stresses and strains resulting therefrom, induced along an axis having a north and south direction, have resulted in the production of a series of joints, etc., which have formed the channels up which mineral-bearing solutions have percolated and deposited in one place free quartz forming the persistent reefs, and in the other have attacked some of the constituents of the granite. The result of this chemical action has been the production of a rock made up principally of quartz albite, a little mica, together with a few garnets and cassiterite.

Practically all the tin hitherto obtained from Moolyella and elsewhere in the district is derived from the alluvial deposits found in the existing valleys, and to a certain extent from the deposits of residual tin, *i.e.*, ore derived from the decomposition *in situ* of tin-bearing pegmatites, which occurs all over that portion of the granite area which is reticulated by pegmatite veins; these afford a good standby for prospectors at such times as prospecting in other portions of the district becomes impossible.

Lode tin is known to occur at Moolyella, but owing to low percentage has not been worked. There is every encouragement to search for richer deposits over the 900 square miles which the tin-bearing granitic rocks have been proved to occupy.

The production of Marble Bar district is given below :—

Production of Tin Ore from the Marble Bar (Pilbara) District.

Yea	Quantity.	Value.
	tons.	£
Previous to 1899	75·45	4,419
1899	57·50	3,612
1900	387·87	27,174
1901	412·98	21,148
1902	216·35	15,103
1903	292·11	21,528
Total	1,442·26	92,984

The following tables show the total production of tin ore in the State and the export of ore and ingots up to the end of 1903, also the value of the more important imports for the last five years :—

Total Production of Tin Ore.

Year.	Quantity.	Value.
	tons.	£
Previous to 1899	1,665·78	70,527
1899	334·82	25,270
1900	823·49	56,702
1901	734·32	40,000
1902	619·56	39,783
1903	817·05	55,890
Total	4,995·02	288,172

Tin Ore and Ingots Exported.

Year.	Ore.		Ingots.	
	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£
Previous to 1899 ...	1,738·28	76,227	...	...
1899	307·96	23,163	...	...
1900	470·28	38,178	142·35	18,872
1901	506·50	39,495	96·50	12,607
1902	279·00	22,568	141·00	16,380
1903	291·70	22,856	235·35	29,277
Total	3,593·72	222,487	615·20	77·136

Value of Tin Imports (1899 to 1903).

Year.	Ingot.	Foil.	Plate.	Wares and Manufactures.
	£	£	£	£
1899	2,647	79	901	3,270
1900	2,633	175	2,507	4,390
1901	*635	122	2,445	4.175
1902	*223	286	3,942	3.107
1903	81	†503	2,494	§
Total	6,219	1,165	12,289	...

* Includes block tin. † Includes both leaf and foil. § See footnote to appendix marked §.

LEAD.

The production of lead or lead ore in the State, though at one time giving indication of rising to the dignity of an important industry, has of late years very greatly decreased, the industry being handicapped by the ore not containing sufficient silver to pay for its extraction.

Lead ores have only been worked so far as Uaroo, Geraldine, Northampton, Oakagee, Narra Tarra, and Jarrahdale.

The lodes are mainly composed of cerussite at the surface and galena below the water-level, accompanied by more or less quartz and other gangue minerals. Anglesite occurs freely at Gorge Creek, Ashburton; and jamesonite at Mt. De Courcey, North-West; whilst fine specimens of crystallised pyromorphite have been obtained from the Geraldine Mine, on the Murchison River.

Small quantities of galena are frequently found to characterise the richer portions of gold reefs, notably at Menzies, Coolgardie, and Norseman; whilst small lemon-yellow crystals of the rare mineral vanadinite (chlorovanadate of lead, $PbCl_23Pb_3V_2O_8$) are found closely associated with gold in the oxidised ores of Pinyalling, Mulline, and Coolgardie.

The chief sources of supply have been the mines of Northampton, in the Yandanooka mining district, and those of the Ashburton Goldfield. The ore is to a large extent associated with copper ores and by far the greater proportion of that raised has been exported without further treatment.

NORTHAMPTON.

Practically the whole of the lead ore exported from the State has been obtained from the Northampton district, which occupies an elevated tract of country formed by the tributaries of the Bowes River.

A series of sandstones and conglomerates once covered the whole surface of the ground but from beneath these sedimentary beds now emerge those granites, gneisses, mica schists, quartz schists, etc., intersected by veins and masses of pegmatite, which are of chief interest from an economic point of view.

The most important feature in the structural geology of the district is the system of basic dykes with which the whole area is seamed. These dykes are continuous for a great distance and parallel to them are the lodes of lead and copper which have been opened up, but there are no mines deeper than 300 feet.

The following table shows the export of lead ores from the Northampton Mining District, which, it will be seen, accounts for the total export from the State :—

Export of Lead Ore from the Northampton Mining District.

Year.	Quantity.	Year.	Quantity.
	tons.		tons.
1850	5·00	1876	2,191·50
1851–2	*Nil*	1877	3,955·50
1853	*	1878	3,617·50
1854	*Nil*	1879	2,775·00
1855	25·00	1880	1,921·00
1856–8	*Nil*	1881	1,400·50
1859	13·50	1882	1,793·50
1860	98·50	1883	1,038·00
1861	79·00	1884	696·00
1862	9·00	1885	465·00
1863	230·00	1886	611·00
1864	80·00	1887	471·00
1865	703·00	1888	532·00
1866	273·50	1889	250·00
1867	902·00	1890	213·50
1868	1,100·50	1891	25·00
1869	699·50	1892	29·75
1870	1,209·50	1893–6	*Nil*
1871	420·00	1897	*
1872	364·00	1898	5·00
1873	965·50	1899	16·00
1874	2,143·75	1900	26·85
1875	2,289·00	1901–3	*Nil*
Total quantity exported			33,643·85

* Declared at £4, tonnage not stated.

The total production of lead ore and pig lead in the State is shown in the table below:—

Production of Lead Ore and Pig Lead.

Year.	Lead Ore.		Pig Lead.		Total Value.
	Quantity.	Value.	Quantity.	Value.	
	tons.	£	tons.	£	£
1850 to 1860	142·00	1,429	577·00	11,640	13,069
1861 to 1870	5,286·00	62,636	3·00	50	62,686
1871 to 1880	20,642·75	240,029	17·25	348	240,377
1881 to 1890	7,470·50	59,887	9·00	180	60,067
1901 to 1903	...	...	...	...	...
Total	**33,643·85**	**364,756**	**683·75**	**13,306**	**378,062**

The following tables show the values of the exports of lead and lead ores, and the more important imports, for the last five years:—

Value of Lead Exports (1899 to 1903).

Year.	Lead Ore.	Pig Lead.
	£	£
1899	96	28,220
1900	242	47,513
1901	...	45,770
1902	...	8,884
1903	...	...
Total	**338**	**130,387**

Value of Lead Imports (1899 to 1903).

Year.	Sheet, pig, scrap, and piping.	Shot, bullets, and slugs
	£	£
1899	1,685	139
1900	16,210	265
1901	48,828	263
1902	25,429	353
1903	4,333	1,119
Total	**96,485**	**2,139**

SILVER.

The production of silver in Western Australia amounted at the end of 1903 to 341,024ozs., the metal being obtained mainly as a bye product.

There are no silver mines being worked in the State, though in the lead deposits of the North-West there is a source of silver which, up to the present, has hardly been touched. Numbers of the gold ores contain silver, the average Kalgoorlie ore being said to contain about 1oz. of silver for every 2ozs. of gold; but very little of the former seems to be recovered in the treatment to which the ore is subjected.

The crude gold produced in the State has now an average fineness of about ·8379, and contains a good deal of silver. Apart from this very little silver has been produced in the State, except the small amount obtained in smelting copper ores and telluride ores.

The quantity and value of the silver produced in the State and entered for export from 1900 to 1903, which is the nearest approach to the annual output, is as shown in the table below:—

Production of Silver.

Year.	Quantity.	Value.
	ozs.	£
1900	28,749	3,594
1901	60,869	7,609
1902	83,293	9,199
1903	168,113	19,153
Total	**341,024**	**39,555**

The amount of silver-lead ore which was obtained from the Ashburton Goldfield is shown below:—

Production of Silver-Lead Ore.

Year.	Quantity.	Value.
	tons.	£
1902	21·05	152
1903	35·85	277
Total	**56·90**	**429**

The following tables show the value of the silver bullion and coin entered for export and imported during the last five years:—

Value of Silver Exports and Imports (1899 to 1903).*

Year.	Silver not classified.	Bullion.	Coin.
Exports.	£	£	£
1899	15,709	...	...
1900	28,214	...	...
1901	44,638	...	...
1902	19,240	...	...
1903	...	23,701	933
Total	**107,801**	**23,701**	**933**
Imports.*			
1899		1	...
1900		20	3,478
1901		...	24,650
1902		...	†17,340
1903		12	...
Total		**33**	**45,468**

* For other silver imports *see* Appendix. † Includes copper coin.

IRON ORES.

Iron ores are very widely distributed throughout Western Australia, but, with one or two exceptions, the area in which the exploitation of such deposits is actively prosecuted is very limited, such areas being at present confined to localities where ore used as a flux can be obtained in considerable quantities.

The greater iron deposits of the State have not so far been worked, some of the richest and most extensive being, from their geographical position, under present conditions practically valueless. Those of the Murchison stand out prominently before any others, and though neglected at present are destined to form a very important State asset. The position of the Murchison deposits with reference to the nearest seaport is shown in the table below, and also with respect to the nearest coalfield, but no coal suitable for smelting purposes has yet been found in Western Australia.

Deposit.	Distance from nearest seaport by rail and road.	Distance from railway line.	Distance to nearest coal-field by road and rail.
Mt. Hale ...	362 miles, Geraldton	100 miles, Cue	441 miles, Irwin River
Mt. Narryer	362 " "	100 " "	441 " "
Wilgie Mia ...	312 " "	50 " "	391 " "

Of the iron deposits generally those so far examined can be broadly separated into two main divisions—(*a*) the ores associated with the crystalline schists and other allied rocks; and (*b*) the superficial deposits of limonite (laterite ore), which occupy extensive areas in many and widely separated portions of the State; and the soft porous deposits of hydrated oxide of iron (bog ore) of comparatively recent origin.

ORES ASSOCIATED WITH CRYSTALLINE SCHISTS.

The most important deposits associated with the crystalline schists are those of the Murchison already referred to, developed most extensively between 25 degrees and 28 degrees of south latitude, and 116 and 119 degrees east longitude. The principal localities are Horseshoe, Peak Hill, Mount Gould, and Mount No Name (Peak Hill District); and Mount Hale, Weld Range (Wilgie Mia); Munara Hills and Mount Narryer (Murchison District). Less important deposits of this nature occur at Kilalo Well (Murchison District); Marble Bar (Pilbarra District); Wiluna, Mount Townsend, and Mount Marion (East Murchison District); Bardoc (Broad Arrow District); Mount Jackson (Yilgarn District); and Jennapullen, Blackboy Hill, and Greenhills (Avon District).

These deposits consist of highly inclined beds, bands, and lenses of almost pure hematite (occasionally magnetite) or admixtures in all proportions of hematite and quartz, interbedded with and sometimes replacing quartzites and quartz schists.

Mounts Hale, Taylor, etc.—The sigma-shaped range of hills on the west side of the Murchison, of which Mounts Taylor, Hale, Matthew, Yarrameedie, and Erawandoo form the most prominent summits, is remarkably prolific in iron-bearing schists. The summit of Mount Hale is formed of contorted quartz schists, with bands of hematite, which occur in lenticular masses; some bands are often as thin as a sheet of paper, whilst others widen out to considerable dimensions. One band measured 70 feet across and outcropped for over a quarter of a mile, but varied in thickness in different parts. There were similar bands parallel to it and equally persistent along the strike. Just under the western summit of Mount Hale the quartzite is replaced by a great bed of hematite, several huge monoliths of which stand out prominently on the range. This hematite can be followed along the range to a point just south of the summit of Mount Matthew.

The outcrop of a bed of ironstone forms a conspicuous feature on the surface at the foot of the Mount Narryer Range. The bed, which is vertical, attains a thickness of eight or nine feet, and rises about two feet above the ground.

In the Weld Range, at the head of the Roderick River, is the Wilgie Mia, said to be one of the richest iron lodes in the world. This deposit was worked by the natives before the white invasion of Western Australia, and the ore (used as war paint) was traded for great distances. It has been opened up by them to a depth of over 100 feet, and at the bottom of the excavation to a width of 50 yards.

The deposit, which is of almost pure hematite, is roughly some 150 feet to 200 feet in width, and forms a ridge about three miles in length, rising in places to a height of 400 feet above the plain. The deposit is undoubtedly of similar origin to the hematite-bearing quartzites which form the main axis of the Weld Range, and which are so prevalent throughout the whole of the Murchison goldfield, the only difference being that in this case silica is almost entirely absent and the lode is composed of almost pure hematite, with magnetite and limonite, resulting from the gradual replacement of greenstone schists by iron-bearing solutions.

The dip of the lode is very nearly vertical. As sulphides are not likely to be met with above water level—which is about 60 feet below the surface of the plain—it will be thus seen that there is an immense body of very high-grade iron ore here.

A second somewhat similar deposit is said to exist about two miles to the north-eastward of Mount Lulworth.

The following are three partial analyses of samples of iron ore from the Wilgie Mia, and one also of a sample (IV.) of hematite-bearing quartzite from the Weld Range:—

Analyses.	I.	II.	III.	IV.
	per cent.	per cent.	per cent.	per cent.
Metallic Iron	63·87	64·36	68·83	35·50
Silica	2·48	1·38	1·00	43·42
Phosphorus	·090	·052	small trace	·089
Sulphur	·033	·023	·035	·036
Water (hyg.)	·89	·57	·19	·15
Water (combined)	1·52	·60	·35	4·17

Traces only of titanium were present in these samples.

Samples I., II., and III. represent very rich hematite ores, extremely low in sulphur and silica and free from titanium. The phosphorus percentage in I. is somewhat above the Bessemer limit; pig iron smelted from it would, however, make good stock for the production of "basic" steel. The phosphorus percentage in sample II. is just about the permissible limit for the cheaper Bessemer process; but sample III. is extremely pure and low in phosphorus, and as there is a considerable quantity of this quality of ore present, the whole deposit, if it is ever worked, will probably prove of such grade as to permit of the use of this process of steel manufacture. Regarding the probable quantity of ore present, an estimate has been made of the amount in sight, *i.e.*, actually above the level of the surrounding plains, as roughly, 26½ million tons.

In addition to this deposit, there are the hematite-bearing quartzites which traverse the Weld Range from end to end, and of which (IV.) is a typical sample. These deposits, of which there is practically an inexhaustible supply, and amongst which there are said to be other rich patches similar to the Wilgie Mia deposit, though of rather too low grade for smelting purposes as they now exist, could, with the employment of suitable concentrating machinery, be converted into first-class ores, and during this process of concentration would doubtless lose a considerable portion of their phosphorus contents. These remarks also apply to the hematite-bearing quartzites found in such large quantities all over the Murchison Goldfield, which frequently contain from 30 to 40 per cent. of metallic iron. With regard to the probability of these ores living to a depth, similar deposits (of hematite-bearing quartzites) have been proved to exist to a vertical depth of 250 feet at Boogardie and Lake Austin, apparently without any change in their mineral constitution beyond a slightly increased sulphur percentage.

SUPERFICIAL DEPOSITS AND BOG ORES.

The superficial deposits comprise the laterite ores and the bog iron ores. The laterite ores, together with the gravel resulting from their denudation, are the most widely distributed ores in the State; they vary very much in their composition. The ores are most largely developed on the tops of hills or ranges; in depth they pass gradually, without any distinct line of demarcation, into the rock upon which they lie. These deposits owe their origin to the concentration of the ferric oxide by the action of atmospheric changes. Nowhere do any of these ores attain any great thickness. The ores of this class have been principally used for fluxing purposes, to which end 50,792 tons have been raised up to the end of 1903.

The bog iron ores consist of soft porous deposits of hydrated oxide of iron; these occur at different points along the southern and western coast line. Up to the present, however, deposits of this class have not been exploited.

The following table shows the production of iron ore in Western Australia used principally for fluxing purposes, and some particulars are also given in tabulated form of the imports and exports of pig iron and certain manufactures for the last five years:—

Production of Iron Ore.

Year.	Ore raised.	Estimated Value.
	tons.	£
Previous to 1899	100	300
1899	12,852	8,939
1900	12,251	9,258
1901	20,569	13,246
1902	4,800	2,040
1903	220	88
Total	**50,792**	**33,871**

Value of Exports and Imports of Iron and Steel (1899 to 1903).*

Year.	Pig and Scrap.	Bar, Plate, Sheet, and Rod.	Structural, Girders, etc.
*Exports.**	£	£	£
1899	878	642	...
1900	1,056	1,999	...
1901	1	562	...
1902	10	354	...
1903	247	1,786	...
Total	2,191	5,343	...
*Imports.**			
1899	5,069	16,407	1,994
1900	9,590	28,020	4,903
1901	7,971	39,209	7,690
1902	14,483	33,060	10,306
1903	21,467	54,361	7,952
Total	68,580	171,057	32,845

* For all other and manufactures, *see* Statistical Register of Western Australia, Part IV. (Interchange).

ANTIMONY ORES.

Ores of antimony occur in the Mallina, Peewah, and Roebourne Districts, West Pilbara Goldfield.

There are some good lodes of stibnite, and the value in most cases is greatly increased by the gold they contain; the production, however, has been limited to the export of a single parcel in 1903.

Exports and Imports of Antimony Ores.

Year.	Quantity.	Value.
Exports.	tons.	£
1903	22	230
Total	**22**	**230**
Imports.		
1901		9
1902		*nil*
1903		*nil*
Total		**9**

COBALT ORES.

Asbolite, the only ore of cobalt which has, so far, been recognised in the State, occurs at Norseman and somewhat abundantly in parts of the deep leads at Kanowna, principally in the "pug" or bedded kaolin, and in the underlying much-weathered chlorite schists, from which it has doubtless been originally derived. It is either so thoroughly intermingled with the clay as to be inseparable from it, or else is found in lumps or lining vughs in a soft mammilated form, with a bright grey metallic lustre. It occurs also in the nodules of magnesite found at the junction of the "pug" and the adjacent schists. A sample of "pug" carrying asbolite was found to assay:—

Cobalt	7·56 per cent.
Copper	·02 per cent.

A similar mineral occurs at Kalgoorlie in veins and impregnations in the oxidised portions of the lodes.

No production of cobalt ore has been reported to the Mines Department, but it appears from the Customs records that a small amount, shown in the table below, has been exported in 1902:—

Export of Cobalt Ores.

Year.	Quantity.	Value.
	tons.	£
1902	2	41
1903	*Nil.*	*Nil.*
Total	**2**	**41**

PART II.

NON-METALLIFEROUS SUBSTANCES.

COAL.

The coal produced in Western Australia, owing to the quality being unsuitable for export, is almost entirely consumed within the State. The total output up to the end of 1903 amounted to 568,400 tons; in value, £306,424. During the year there was a decrease in the output of five per cent. owing to labour disputes, resulting in a cessation of operations for several weeks at the Collie Proprietary, one of the chief producers.

Coal of three different ages is known in the State, viz., in the Carboniferous Beds of the Irwin River, the Mesozoic Beds of the South-West, and the Post-Tertiary Beds of Coolgardie and the south coast. All the coal hitherto discovered has proved to contain a considerable proportion of water, belonging either to the class of splint (hydrous bitiuminous) coals or to that of lignites.

Of the Irwin River Coalfield, where the carboniferous rocks occupy an area of about 200 square miles, it may be said that though a workable seam has not yet been discovered, the base of the formation has never been unequivocally reached by any of the boring operations which have been carried out up to the present. Two seams occur in the upper part of the formation, from samples of which the following results were obtained from the results of six analyses :—

Chemical Analyses of Coals from the Irwin River Basin.

Description.	Moisture.	Volatile Hydro-carbons.	Fixed Carbon and Ash.	Sulphur.
Mean of Six Samples	19·59	22·64	57·76	0·19

Areas of similar rocks occur at the Greenough and Gascoyne Rivers, but have not yet been thoroughly tested.

The only coals which have been worked in the State are the Mesozoic coals of the Collie River Coalfield. This field embraces an area of about 50 square miles, and is connected with the main railway system of the State.

The coal measures have been deposited in a comparatively unsymmetrical shallow basin of erosion. The strata do not appear to have been subjected to any serious disturbance, and to have suffered little or no lateral pressure. So far as mining operations have at present been carried, the beds all dip at a comparatively low angle into the basin. This low dip may, in part, be due to the changes produced by the consolidation and the settling of the strata in the basin in which the vegetable and other matter was deposited. The effects of this settling are shown by the small faults, in reality cracks, which have been discovered in the course of the workings along the edge of the coal basin.

A considerable number of workable seams have been proved, by mining and boring, to exist in this basin, the deepest so far met with being pierced at 800ft., on the Collie Boulder Company's property.

The coal seams vary in thickness from that of a sheet of paper up to about 13 feet, and all the seams are practically identical in nature, being hydrous, non-caking, bituminous coals, varying noticeably only in the proportion of ash present.

The coal from the better portions of the seams is bright and evenly bedded, but fragile, partly owing to the numerous partings of mother-of-coal in it, partly owing to spontaneous decrepitation accompanying a loss of moisture on exposure to the air. A coal of this kind contains less than half the average percentage of ash. The poorer qualities of coal contain considerably larger percentages of ash and correspondingly smaller proportions of the other constituents, becoming physically harder, denser, and more massive, with a conchoidal fracture.

The following table gives the mean results obtained from analyses of 23 samples of Collie coal:—

Proximate Analyses of Collie Coal.

Description.	Specific Gravity.	Calorific Value.		Percentage Composition.				
		Pounds of Water evaporated.	British Thermal Units.	Moisture.	Volatile Hydro-carbons.	Fixed Carbon.	Ash.	Sulphur.
Mean of 23 samples ...	1·379	10·71	10,340	12·46	29·63	48·81	9·10	·50

Tertiary and Post-Tertiary lignites and brown coals, mostly of poor quality, are known to occur in several of the valleys along the south coast, and a seam of brown coal occurs to the south-east of the town of Coolgardie, at a depth of 65 feet, in a series of horizontally bedded pleistocene rocks, some 400 feet in thickness.

The coal from the seams of this class which have so far been located contains an extremely large percentage of ash.

Details of the production of coal in Western Australia, which is entirely that of the Collie Coalfield, are shown in the tables below, and also the exports and imports of coal, coke, and patent fuel for the last five years:—

Production of Coal.

Year.	Coal raised.	Value.
	tons.	£
Previous to 1899	3,508·00	1,761
1899	54,336·00	25,951
1900	118,410·10	54,835
1901	117,835·00	68,561
1902	140,883·90	86,188
1903	133,426·62	69,128
Total	**568,400·42**	**306,424**

Value of Coal Exports (1899 to 1903).

Year.	Value.
	£
1899	45,283
1900	83,421
1901	165,888
1902	93,135
1903	58,194
Total	**445,921**

Value of Imports of Coal, Coke, and Patent Fuel (1899 to 1903).

Year.	Coal.	Coke and Patent Fuel.*
	£	£
1899	95,144	1,968
1900	110,699	15,259
1901	158,471	27,544
1902	133,769	25,820
1903	69,686	4,211
Total	567,719	74,802

* Character not specified.

LIMESTONE, BUILDING STONES, CLAYS, ETC.

Limestone is used in the State as a flux for metallurgical purposes, as a building stone, for cyaniding purposes, and for the preparation of quicklime.

The production of limestone in the State up to the end of 1903, so far as it can at present be estimated, amounts in value to £12,298, but owing to the number of privately-owned quarries, complete annual returns have not been recorded.

Limestone occurs throughout the recent and tertiary formation which occupies so large an area along the coast. The rock of the coastal limestone series, from the mode of formation, varies greatly in the quantity of lime present, being frequently more a calcareous sandstone, which is used to a considerable extent for the stonework of small buildings. In the municipality of Perth the stone used for this purpose is obtained chiefly from Cottesloe and Rottnest Island.

The sources of supply for building stones of higher grade are Meckering, on the Eastern Goldfields Railway, from which a fine-grained granite is obtained; and Donnybroook, from which is obtained a compact light-coloured sandstone, which is coming into much favour for building purposes. Marble, etc., for ornamental purposes, is imported.

Extensive beds of porcelain clay and terra cotta have been proved, by boring, to overlie the extension of the deep lead at Kanowna, but have not so far received much attention.

Brick clays are worked in nearly all parts of the State and fire-clays have been worked at several of the collieries of the Collie Coalfield. No statistics, however, are yet available which will enable the production of structural materials, clays, etc., to be arrived at.

Tables are given below showing the actual figures available with regard to the production of limestone, which, for the reasons already stated, is an incomplete record, and also the imports of clay, clay products, and stones of all kinds, for the last five years:—

Production of Limestone.

Year.	Quantity.	Value.
	tons.	£
1899	17,593·00	2,838
1900	15,926·85	3,594
1901	18,210·00	4,348
1902	5,080·35	1,340
1903	1,279·50	178
Total	**58,089·70**	**12,298**

Value of Imports of Fireclay, Clay Products, and Stones of all kinds (1899 to 1903).

Year.	Fireclay.	Bricks.*	Earthen and China-wares.	Earthen-ware Drain Pipes.	Tiles.
	£	£	£	£	£
1899	272	1,863	10,705	1,784	928
1900	177	1,557	15,126	1,987	1,823
1901	277	1,753	18,882	4,197	357
1902	720	1,544	7,301	12,118	† 1,367
1903	190	798	7,118	10,505	† 3,021

	Marble Stone and Slate (rough).	Marble Stone and Slate (wrought).	Stone sawn and in the rough.	Other stones not otherwise specified.
1899	1,458	1,041	...	151
1900	1,344	902	...	141
1901	2,104	1,458	...	250
1902	1,890	‡ 1,663	...	**
1903	1,460	‡ 1,921	2,083	**

	Grindstones, Oilstones, and Whetstones.	Litho. and Emery Stones.	Pumice.
1899	217	§	§
1900	154	§	§
1901	438	§	§
1902	753	236	42
1903	718	§	36

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* Chiefly fire, includes also air and bath. † Includes Asphalt and Roofing Tiles. ‡ Includes Slate Roof and Slab. ** *See* footnote to Appendix marked**. § *See* footnote to Appendix marked§.

PRECIOUS STONES AND PEARLS.

The production of Precious Stones in Western Australia has, so far, been limited to 25 small diamonds, which were supposed to have come from the Pilbara District; but the output of pearls, some particulars of which it is not inappropriate to add in this connection, is of considerable annual value.

A number of minerals of the character of precious stones occur in the State, some in the particular varieties which are classed as gems, and specimens are from time to time examined in the Laboratory, and the localities recorded.

Tiger's eye (*Crocidolite*).—A deposit of this mineral occurs at Yarra Yarra Creek, in the Murchison District. The deposit was opened up to a slight extent under the name of the Bulgroo Opal Mine, but none of the material was ever placed in the market. During the last year some pieces of it were cut and polished in the Laboratory, and a representative series of considerable beauty placed in the Museum. Some of this was sent to Dr. Geo. F. Kunz, the well-known American gem expert, who expressed the opinion that it was more beautiful than the original South African gem.

Garnets.—Some fine garnets are said to occur near Uaroo, Lynden District.

Moonstone.—Good moonstones have been discovered on the beach at the mouth of the Bowes River, Victoria District, which appear to have been washed out of a mesozoic conglomerate outcropping at the water's edge.

Tourmaline.—Pink and green tourmaline have been found at Coconarup, embedded in a hard coarse pegmatite.

Opal.—Precious opal occurs at Coolgardie, but the small deposit, being the result of secondary silicification in hard metamorphosed rocks, would not be likely to pay to work commercially.

With regard to the output of pearls, the principal centres of the industry are Broome, Roebourne, Onslow, and Sharks Bay, on the North-West and West coasts. The total value of the pearls obtained during 1903, exclusive of the value of the shell, is estimated to be £50,000.

Tables are given below showing the production of diamonds and the value of the exports and imports of precious stones and pearls for the five years from 1899 to 1903:—

Production of Diamonds.

Year.	Value.
	£
1899	*24
1900 to 1903	nil
Total	24

* Twenty-five small diamonds found in battery box after crushing auriferous conglomerate from Nullagine.

Exports and Imports of Precious Stones and Pearls (1899 to 1903).*

Year.	Precious Stones.†	Pearls.‡
Exports.	£	£
1899	...	20,000§
1900	...	20,000§
1901	1,008	25,000§
1902	580	40,000§
1903	423	50,000§
Total	2,011	155,000
Imports.		
1899	514	...
1900	436	...
1901	445	...
1902	4,173	...
1903	1,173	...
Total	6,741	...

* Exclusive of value of shell. † Source and kind not recorded. ‡ Product of State. § Estimated value.

MICA.

What may be called possible commercial mica is known to occur at the following different places in the State:—Nokenena Brook, Northampton; Tambourah, Pilbara Goldfield; Mullalyup, Darling Ranges; Bindoon; The Mica Mine, Londonderry, Coolgardie Goldfield.

Mica is probably one of the minerals most widely diffused throughout the State; but it is only of any real commercial value when it occurs in large sheets, or can be obtained in considerable quantities. The mica-producing strata are the crystalline schists and allied rocks, which occupy fully two-thirds of the (geologically) known areas of Western Australia. Generally it is found that the mica-producing rocks are pegmatitic granites, which traverse the crystalline schists, etc., either in the form of dykes, sheets, or lenticular masses, which are often parallel to the foliation of the surrounding strata.

Under the generic term "Mica" several distinct mineral species are included; they are all characterised by the readiness with which they split into very thin, elastic plates. Four of the species are of commercial importance, viz., Muscovite (common or white mica); Phlogopite (amber mica); Biotite (black mica); and Lepidolite (lithia mica). They all occur under somewhat similar geological conditions.

Up to the present it does not appear that much mica of marketable value has yet been raised in the State. The following tables give the export of mica and the imports from 1899 to 1903, as shown by the records in the Customs House.

Total Value of Mica Exported, and the Value of Imports from 1899-1903.

Year.	Value.
Exports.	£
1892	25
1893	4
1894	*Nil*
1895	3
1896	*Nil*
1897	209
1898	*Nil*
1899	50
1900	3
1901 to 1903	*Nil*
Total	**294**
Imports (1899 to 1903).	
1899	...
1900	...
1901	1
1902	132
1903	§

See footnote to Appendix marked§.

ASBESTOS.

Asbestos has been found in widely-separated localities in the State; but, so far, with the possible exception of that from Tambourah, on the West Pilbara Goldfield, most of the mineral discovered up to the present time has proved to be actinolite, of so coarsely fibrous a nature as to be practically valueless.

The asbestos from Tambourah turns out to be fibrous chrysotile, identical with the Canadian mineral, which is so much valued. The Tambourah asbestos, unlike most of the Australian mineral, has not the great defect of a low tensile strength, and in all the points—infusibility, softness, flexibility, fineness, and the ease with which the fibres can be separated—is well above the average. No scientific examination of the district having been undertaken, information as to the mode of occurrence of the mineral is unfortunately not available.

The following tables show the production of asbestos in the State, in so far as may be gauged by the export records of H.M. Customs House and also the imports for the years 1899 to 1903:—

Total Value of Asbestos Exported and the Value of Imports from 1899 to 1903.

Year.	Value.
Exports.	£
1899	1
1900	*Nil*
1901	*Nil*
1902	*Nil*
1903	10
Total	**11**
Imports (1899 to 1903).	
1899	863
1900	985
1901	839
1902	1,286
1903	§

§ See footnote to Appendix, marked §.

SALT.

Salt is obtained from certain depressions in the calcareous sandstones of the coast, which are filled to a shallow depth in winter with salt water, the salt in which is probably derived from sea-spray. In the summer the lakes dry up completely, leaving a layer of salt two or three inches thick, which is collected and either consumed locally or exported, both as a fine and crude product.

The two localities where salt-collecting has been carried on are Fremantle and Esperance, in the former at Rottnest Island, and the latter at Middle Island; from both a very pure product is obtained, containing, when dry, from 98 to 99 per cent. of pure chloride.

The following tables show the production of salt at Rottnest Island and Esperance, so far as records are available. Tables showing the value of the exports of salt and the imports into the State from 1899 to 1903 are also given:—

Production of Salt at Rottnest and Esperance.

Year.	Rottnest.				Esperance.		Total Value.
	Fine.		Crude.				
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	tons.	£	tons.	£	tons.	£	£
1868 to 1898	2,185·50	6,824·59	380·50	380·50	...	...	7,205·09
1899 ...	75·00	198·75	25·00	25·00	248·00	248·00	471·75
1900 ...	97·50	258·37	21·00	21·00	...	...	279·37
1901 ...	69·00	182·85	21·00	21·00	50·00	69·00	272·85
1902 ...	71·00	188·15	21·00	21·00	...	...	209·15
1903 ...	...	...	...	...	54·00	87·00	87·00
Total ...	2,498·00	7,652·71	468·50	468·50	352·00	404·00	8,525·21

Values of Exports and Imports of Salt (1899 to 1903).

Year.	Rock.	Other kinds.
Exports.	£	£
1899	...	249
1900	...	4
1901	...	75
1902	...	...
1903	...	87
Total	...	**415**
Imports.		
1899	41	2,858
1900	70	3,193
1901	37	3,183
1902	73	3,462
1903	54	3,209
Total	**275**	**15,905**

GUANO.

The economic importance of the accumulations of guano occurring in the Abrolhos Islands and elsewhere in the North is sufficient justification for referring to them in a description of the mineral resources of the State. No mineral phosphates or fertilisers, other than guano, are produced. That the importance of the island deposits is considerable may be judged from the appended table of statistics, showing the production of guano in the State, as prepared from official data. No record would appear to have been kept of the quantity of guano exported previous to the year 1847; also, during the years 1847 to 1855, 1855 to 1865, 1865 to 1872, 1872 to 1876, and also the years from 1879 to 1882. From the official figures it appears that since 1876 92,342·35 tons of guano were raised, and that the total royalty paid to the Government from that date amounted to £41,995·75. From the year 1847, as shown by the Customs figures, 86,165·25 tons of guano, valued at £335,591·75, were exported from the State. Up to the present time the chief source of the guano raised is in the Houtman Abrolhos Islands, West of the town of Geraldton.

In August, 1897, Mr. Licensed Surveyor Wells was despatched from Geraldton to the Abrolhos Islands for the purpose of officially estimating the quantity of guano still available on the group. This officer visited 10 islands of the Eastern group, and on four of them, viz., Rat, Third, Beacon, and Wooded Islands, found guano deposits varying from four inches to 27 inches in thickness. The islands of the Eastern group are estimated to contain 13,944 tons of guano. Of the 14 islands of the Pelsart group examined, nine were found to contain guano deposits, viz., Pelsart, Gun Island, and seven small islands adjacent. The deposits varied from seven inches to 13 inches in thickness. The group is supposed to contain 48,468 tons of guano. Mr. Wells examined 18 islands of the Wallaby group, but only made surveys of four, viz., West Wallaby, Pelican Island, and North and South Pigeon Islands. These were estimated to contain 38,088 tons of guano, varying in thickness from four inches to 17 inches. Small quantities of guano also occur in several of the lesser islands.

The following tables show the production and exports of guano, also the imports of fertilisers, from 1899 to 1903, the character of which however cannot, from the available records, be accurately specified :—

Production of Guano.

Year.	Quantity	Royalty paid.		
	tons.	£	s.	d.
1876–1880	36.754·15	18,377	1	6
1881–1890	21,396·00	11,480	6	3
1891–1900	28,023·20	10,936	12	3
1901	1,692·00	*590	16	0
1902	1,930·00	†287	0	0
1903	2,547·00	‡323	19	4
Total	**92,342·35**	**41,995**	**15**	**4**

* 857 tons for use in State were free from Royalty. † 1,130 tons for use in State were free from Royalty. ‡ 1,878 tons for use in State were free from Royalty.

Exports of Guano.

Year.	Quantity.	Value.
	tons.	£
1847–1880	28,652·00	183,781·50
1881–1890	25,880·50	131,217·25
1891–1900	27,181·75	61,017·00
1901	1,099·00	2,742·00
1902	2,400·00	4,800·00
1903	952·00	2,034·00
Total	**86,165·25**	**335,591·75**

Values of Imports of Fertilisers (1899-1903).*

Year.	Value.
	£
1899	18,491
1900	17,036
1901	18,632
1902	23,040
1903	32,048
Total	**109,247**

* Character not specified.

ARTESIAN WATER.

The Artesian water of the State, though often containing an appreciable amount of mineral salts in solution, cannot in a strict sense be termed a mineral water; but the direct connection of its occurrence with the geology of the country, and its importance as a factor in the water supply of a large portion of the State render no apology necessary for including some particulars with regard to its occurrence and the quantity at present available.

In its broader topographical features, Western Australia falls naturally into three divisions of different physical character:—

(*a*.) The Coastal Plain. This consists in reality of a fringe of strata around the coast, with a more or less gentle slope to the seaward. It is formed for the most part of shallow water deposits, sandstones, conglomerates, and thin shales, with occasionally incoherent sand and clays. It has a width of 60 or 70 miles in places on the Western Coast, though in the country at the head of the Great Australian Bight, being absolutely devoid of rivers, it extends some 200 miles into the interior. Its inner margin reaches an altitude of 600 feet above sea level in certain localities. The Coastal Plain is separated from the interior by a belt of—

(*b*.) Hill Ranges, which form what may be called the escarpment of the Plateau and Plains of the interior. The Hill Ranges have an average elevation of about 1,200 feet, though isolated ranges reach altitudes of 4,000 feet above sea-level. This escarpment has a short or steep slope down to the edge of the Coastal Plain, into which it gradually merges. This belt of country, drained by the rivers of the State, is formed of granitic and metamorphic rocks, the decay of which produces excellent soil; it comprises, owing to its rainfall, the principal agricultural districts of the State.

(*c*.) The Plateaux and Plains of the interior consist of a broken tableland, from which rise isolated hills and ridges of metamorphic rocks, often separated by sandplains of some considerable extent, and containing depressions occupied by saline marshes, clay flats, brine lakes, or deposits of salt. There are no rivers, and the rainfall is slight. This plateau forms the chief mineral region of the State.

The Coastal Plain is of considerable economic importance, in that the certainty of obtaining artesian water from the underlying strata has been very thoroughly established, and the system of boring for artesian water is capable of great expansion in the State, being limited only by locality.

A glance at any Geological Map of Western Australia shows an enormous extent of Recent and Tertiary strata entering the State at its eastern border, in the Nullabor Plains, and extending without any interruption as far as Israelite Bay. These strata consist of porous limestones associated with beds, into which the rainfall is rapidly absorbed and discharged seawards in the form of fresh water springs. Where these strata have been pierced on the South Australian side of the border, the section invariably shows from 300ft. to 500ft. of sandy water-bearing beds, of undetermined age, covered by a variable thickness of calcareous strata of both Older and Newer Tertiary age. The beds have a prevailing dip towards the Great Australian Bight, and water rises in the bore holes to a height equal to that of the sea level. So far, however, the water obtained has proved to be either salt or brackish, but at any rate suitable for stock purposes.

The whole of the area of these beds in the Southern portion of this State may be described as an artesian water area, though there may be, and undoubtedly are, conditions affecting the water supply, such as local variations in the thickness, the relative porosity of the beds, and the unevenness of the floor upon which they were laid down, which, with our present meagre knowledge, can only be set at rest by the operations of the drill.

The strata of the coastal plain in the vicinity of the Swan River have proved that in certain areas they possess all the conditions necessary for yielding an overflowing supply of water. The structure of the coastal plain differs in some respects from the typical areas in which artesian water has been obtained in the eastern portions of Australia. The strata are horizontal or nearly so, though occasionally there is a slight local dip of about five degrees in places. The effect of this horizontally is shown in the fact that the water-carrying beds do not crop out on the surface, at the foot of the Darling Range, but impinge directly against that portion which is now concealed from view. These beds, clays (marls ?), and sandstones, with occasional limestones, do not maintain a uniform thickness throughout, but are disposed in the form of lenticular beds, some of which appear to be of exceptionally absorbtive properties.

The bores which have already been put down between the Darling Range and the coast have shown how irregular are the strata from which the water has been obtained, and what is of further moment, they also demonstrate that only in one instance has the base of the water-carrying beds been reached.

The first supply of artesian water in the vicinity of Perth was obtained some time during the year 1873. Since then all the available information about artesian wells has been collected and tabulated for convenience of reference. So far as official data show, there are now 44 artesian and sub-artesian wells in the State, of which some particulars of flow, depth, etc., are given in the table below:—

Table of Deep Bores—Artesian and Sub-Artesian.

Locality.	Total depth of Bore in feet.	Depth to principal water-bearing bed below surface, in feet.	Temperature of water Fah. degrees.	Artesian.		Sub artesian.
				Static pressure, in lbs. per square inch, at surface.	Continuous daily flow in gallons when uncontrolled.	Volume pumped or available daily, in gallons.
Wyndham, Town of	690	...	...	*	†	...
Onslow, Town of	1,729	1,015	...	10·82	120	...
Carnarvon	3,011	...	...	8·3	515,000	...
Geraldton	420	...	...	*	†	..
Geraldton	1,531	1,531	..	...	...	11,70
Dongarra	2,111	1,478	104°	9·54	216,000	...
Yardarino	1,607	1,607	86°	..	589,000	...
Midland Junction	500	420	...	8·66	266,000	...
Woodbridge	296	160	...	6·00	124,000	...
Guildford	408	408	...	7·50	60,000	..
Guildford	798	784	...	13·00	192,000	...
Woodbridge	691	691	...	4·75	200,000	...
Guildford	1,202	1,140	..	29·00	1,167,000	..
Guildford	340	304	75°	5·00	71,000	...
Guildford	404	199	...	9·00	65,000	..
Bayswater	1,100	1,070	...	8·00	536,000	..
East Perth	948	948	...	...	217,400	...
Leederville	1,113	1,023	...	4·75	217,000	...
Perth	820	820	...	...	384,000	..
Bagot Road, Subiaco	876	876	...	...	...	450,
South Perth	1,856	1,837	...	...	454,000	...
Causeway, East Perth	1,200	...	...	...	825,000	...
East Perth	1,034	...	...	...	171,700	...
Melville Park	1,487	1,487	91°	17·00	54,000	..
Cannington	1,000	...	...	...	99,000	...
Fremantle	456	434	80°	...	...	565,
Railway Station, Bunbury	30	...	...	...	...	
Government Grant on Estuary, Bunbury	104	97	...	...	...	70,
Reserve 2030, Stirling Street, Bunbury	426	86	...	...	100,000	..
Dardanup	453	...	...	...	...	.
Dardanup	1,032	...	...	...	...	...
Fremantle	1,322	433	...	...	...	1,090,
Reserve 4228, Claremont	1,506	1,189	...	37 00	560,000	.
Guildford	...	..	...	...		..
Eyre No. 2 Site, 30 Miles North of Madura	430	410	...	...	22,000	15,
Eyre No. 1 Site, at Madura	2,101	2,080	...	12	31,000	..
Leederville	1,680	1,375	...	...	...	..
Perth	815	600	...	10·00	217,000	..
Woodbridge	242	236	...	...	160,000	..
Claremont	1,500	1,320	...	...	310,000	
Near Carnarvon	100	...	...	...	...	
Leederville	...	...	...	...	...	...
Midland Junction	322	280	...	...	...	...
Midland Junction	875	600	...	...	1,100,000	...

NOTE.—The Dongarra Bore, though included here for convenience, was put down to test for Coal Measures. * No water. † Bore abandoned.

APPENDIX.

Summary of Values of Minerals and Mineral Products Imported and Exported during each of the Five Years, 1899 to 1903.

Mineral or Product.	1899.	1900.	1901.	1902.	1903.
IMPORTS.	£	£	£	£	£
§Ammonium Carbonate	...	...	6	298	161
§Antimony (*see page* 71)	...	...	...	...	...
§Asbestos (*see page* 83)	..	...	...	...	...
§Asphalt	3,597	5,219	8,028	..	...
§Brass, scrap, sheet, and tube	...	...	151	532	1,041
Do. wares	2,474	3,327	2,406	724	
§Carbon (diamonds)	..	..	3,816	2,135	...
Cement	18,064	14,385	16,837	34,353	21,233
Chalk (Whiting, etc.)	306	351	312	238	234
Clay (*see page* 78)	...	...	...	...	...
Coal, Coke, and Patent Fuel (*see page* 76)	...	...	...	...	...
Copper (*see page* 55)	...	...	..	...	...
Do. sulphate of	110	560	822	433	492
Fertilisers (*see page* 87)	...	...	...	...	...
Fireclay (*see page* 78)	..	...	...	...	...
Glass, sheet, plate, etc.	4,262	6,576	6,801	8,551	10,789
Do. wares	16,916	18,892	22,892	28,448	24,250
Gold, bullion	687	...	13	...	...
Do. coin	5,000	...	...	...	...
Do. foil and leaf *	381	489	518	468	623
Do. plate †	1,594	2,335	918	‡	‡
Iron and Steel (*see page* 70)	...	...	...	...	...
§Iron, sulphate of	6	...	...	...	...
Jewellery	16,868	22,982	28,390	38,893	45,239
Lead (*see page* 63)	...	...	...	...	...
Lime, sulphate of (*see Plaster of Paris*)	...	...	...	...	...
Mica (*see page* 82)	...	.	..	...	.
Mineral Oil	50,899	65,723	88,505	50,402	69,560
Mineral Paints	1,782	3,495	4,991	**	**
§Muriatic Acid	...	...	...	478	1,932
Naphtha	116	157	161	638	1,217
§Nitric Acid	...	...	...	828	..
Paraffin Wax	1,819	1,911	2,869	1,238	5,183
§Plumbago	...	...	3	376	586
Plaster of Paris	194	114	351	1,111	1,023
Precious Stones (*see page* 80, *also Jewellery above*)	...	...	...	...	...
Quicksilver	7,580	5,739	6,335	10,424	6,622
Salt (*see page* 85)	...	...	...	...	...
Silver (*see page* 65, *also Gold above*)	...	...	..	..	..
Smelting Material	42,691	165,941	55,814	911	**
Spelter, Concentrates, etc.	...	..	...	...	8,347

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* Includes silver foil and leaf. † Includes silver plate. ‡ Included in jewellery. § During years where blanks occur, the article, if imported, was probably classified by H.M. Customs under some general heading, and not particularly specified. ** Classified by H.M. Customs under another heading.

APPENDIX—*continued.*

***Summary of Values of Minerals and Mineral Products, etc.*—continued.**

Mineral or Product.	1899.	1900.	1901.	1902.	1903.
Soda and Potash Salts—	£	£	£	£	£
Bi-carbonate of Soda	963	1,829	952	1,211	727
Caustic Soda	1,999	3,008	2,351	...	2,233
Silicate of Soda	57	222	81	...	236
Soda Ash and Nitrate of Potash ...	663	570	1,334	...	509
Soda Crystals	134	108	119	193	80
Alum	31	65	91	39	64
Potassium Cyanide	55,849	129,964	144,819	161,191	170,646
§Saltpetre	...	...	110	...	156
Stone, etc. (*see page* 78)	...	...	...	...	..
Sulphur	259	788	194	300	893
§Sulphuric Acid	2,347	1,468	2,113	1,013	..
Tar and Pitch	1,947	2,251	5,543	**	2,308
Tin (*see page* 60)	...	...	...	...	...
Whiting (*see Chalk above*)	..	...	..	...	...
Zinc	3,306	1,772	2,514	7,596	10,363
Exports.					
Antimony (*see page* 71)	...	...	...	...	...
Asbestos (*see page* 83)	...	...	...	...	...
Brass Wares	...	20	...	...	...
Cement	6	7	...	...	...
Clay, Earthen and China-ware	483	33	48	77	119
Coal (*see page* 75)	...	...	...	...	..
Cobalt (*see page* 72)	...	...	...	...	...
Copper (*see page* 55)	...	...	...	...	...
Fertilisers (*see page* 87)	...	...	...	...	..
Glass, sheet	33	51	..	13	...
Do. wares	1,619	1,107	241	1,084	1,407
Gold, bullion	5,451,368	3,799,124	3,941,876	3,318,958	4,061,767
Do. coin	79,692	1,750,763	2,807,841	4,149,869	4,556,192
Do. plate †	...	...	1,500	‡	‡
Guano (*see page* 87)	...	...	...	...	..
Iron and Steel (*see page* 70)	...	...	...	...	...
Jewellery	1,321	763	427	2,742	3,965
Lead (*see page* 63)	...	...	...	...	...
Mica (*see page* 82)	...	...	...	...	...
Mineral Oil	77	2,326	142	128	38
Mineral Paints	40	45	...	...	...
Pearls (*see page* 80)	...	...	...	...	...
Precious Stones (*see page* 80, *also Jewellery above*)	...	...	...	...	...
Salt (*see page* 85)	...	...	...	...	...
Silver (*see page* 65)	...	...	...	...	...
Soda and Potash Salts—					
Potassium Cyanide	...	...	...	1,000	626
Tar and Pitch	18	1	...	...	810
Tin (*see page* 60)	...	...	...	..	...
Zinc	1,005	635	341	801	879

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† Includes silver plate. ‡ Included in jewellery. § During years where blanks occur, the article, if imported, was probably classified by H.M. Customs under some general heading, and not particularly specified. ** Classified by H.M. Customs under another heading.

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OF
WESTERN AUSTRALIA
P TO THE END OF THE YEAR 1903,

BY

A. GIBB MAITLAND,
GOVERNMENT GEOLOGIST,

AND

C. F. V. JACKSON,
ASSISTANT GEOLOGIST.

*ssued under the authority of the Hon. H. Gregory, M.L.A.
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